256 Gray's Inn Road

A new centre for world-leading dementia and neurology research and academic excellence

Basement Impact Assessment (Plot 1 and 3) Rev 05
February 2021

Intended for
University College London

Document Type
Report

Date
February, 2021

256 GRAYS INN ROAD

BASEMENT IMPACT ASSESSMENT (PLOT 1&3)

Revision History

Revision	Date	Purpose / Status	Document Ref.	Comments
P01	20/11/20	Planning	BEMP-RAM-SW-XX-RP-CG-00-0001	Draft Planning Issue
P02	02/12/20	Planning	BEMP-RAM-SW-XX-RP-CG-00-0001	Draft Planning Issue
P03	04/12/20	Planning	BEMP-RAM-SW-XX-RP-CG-00-0001	Updated Cover Page
P04	09/12/20	Planning	BEMP-RAM-SW-XX-RP-CG-00-0001	Updated Intro Text
P05	19/02/21	Planning	BEMP-RAM-SW-XX-RP-CG-00-0001	Updated with Campbell Reith Audit Comments

Basement Impact Assessment for the redevelopment of the 256 Grays Inn Road project, Plot 1 and 3, to comply to the Camden Council Policy A5 requirements for basement development

This report has been reviewed by the following qualified persons:

Jai Shah (CEng MICE)

Principal Engineer

Matthew Pannett (CGeol)

Principal Consultant

Ramboll
240 Blackfriars Road
London SE1 8NW
United Kingdom

tel +44 (0)20 7631 5291
london@ramboll.co.uk

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Purpose of the report

This Basement Impact Assessment has been prepared by Ramboll UK in connection with the proposed refurbishment and redevelopment of 256 Grays Inn Road to deliver a new world-leading dementia and neurology research centre, as well as additional academic floorspace for University College London.

This Basement Impact Assessment (BIA) has been prepared to comply with the Camden Council Policy A5 requirements for basement development.

This BIA is for the basement that is to be constructed for Plot 1 and 3 as a combined continuous scheme; the basement that is to be constructed for Plot 1 only, is covered in a separate document within this application.

Proposed development

The first phase of the proposed development comprises the partial redevelopment of the former Royal Free Hospital (Plot 1) to deliver a world-leading medical research facility to tackle dementia and neurological diseases. Work on site is currently underway on Plot 1.

Subsequent phases of the approved development comprise the refurbishment of the grade II listed Eastman Dental Clinic and the erection of a new building on the site of the Levy Wing to deliver additional academic space for UCL. This academic space will complement the University's vision for creating a world class environment for education and academic research. The proposed development would also deliver a comprehensive landscaping scheme to open up new publicly accessible spaces within the site, and new public connections across it.

This planning application relates to the proposal to extend the basement of the Plot 3 building underneath the public realm area in the centre of the site to provide two lecture theatres for the academic use. UCL has identified a requirement for larger lecture theatres than would be delivered in the approved scheme. It also reflects UCL's intention to bring the delivery of the Plot 3 basement works forward at the same time as the Plot 1 basement works to deliver the development in a more efficient and less disruptive way.

This planning application also proposes small extensions to the basement of the Plot 1 building to allow for the provision of a sprinkler tank and additional plant.

This report supercedes the Plot 3 BIA submitted in August 2019 submitted with the original planning application and sets out how the proposed amendments affect the detail and conclusions of the original report. This report should be read in conjunction with the original report.

The proposed development for Plot 1 comprises the demolition of the Sussex, Victoria and New Wings, and the construction of a 9-storey development; this comprises a 2-storey basement (approximately 9m below existing Plot 1 basement level and 14m bgl) and a 7-storey superstructure, inclusive of 2-storeys for plant.

The proposed development for Plot 3 comprises the demoltion of the Levy Wing, and the construction of a 4-to-7-to-4-storey development above ground and a 2-storey basement (approximately 8m bgl), where Plot 1 and 3 basements are planned to adjoin.

Only minor works are proposed to the existing student accommodation at Frances Gardner House, comprising the installation of photovoltaic panels on the roof, and alterations to the landscaping within the courtyard.

Site Information

Grid Ref TQ 30720 82429 ***Site Area*** *1.207 hectares*

Current Site Description

The application site at 256 Grays Inn Road is 1.207ha in area, and is bounded to the west by Grays Inn Road, to the north by the Calthorpe Project and the New Calthorpe Estate, to the east by Langton Close, and to the south by Trinity Court and St Andrew's Gardens. The main part of the site occupied by the Eastman Dental Hospital, was vacated and relocated to a new development at Huntley Street in 2019. The Eastman Dental Hospital is made up of a group of buildings comprising:

- the former Royal Free Hospital (Plot 1)
- the grade II listed Eastman Dental Clinic (Plot 2); and
- the Levy Wing (Plot 3).

The proposed basement and above ground development of the Plot 3 site is bounded by the Eastman Dental Clinic to the west, Plot 1 (currently occupied by the Royal Free Hospital building) to the north along with the New Calthorpe Estate. Frances Gardner House bounds the east of the Plot 3 site area. The south side of the site is bordered by St Andrew's Gardens. The ground level across the site with existing elevations is in the order of +17.0 to +18.0m above ordnance datum (AOD), a reduced elevation between the boundary between Plot 1 at +20.5m OD. Plot 1 is the former Royal Free Hospital which comprises the four wings (Alexandra (west), Sussex (north), Victoria (east), New (south)) with a central court yard.

It is considered that the main access to the Plot 3 site will be via Langton Close and through new access proposed from Grays Inn Road between the EDC and Alexandra Wing.

Site History

Maps dating back to 1874 show the presence of the Royal Free Hospital in the north of the site with wards surrounding a central courtyard. The south of the site was occupied by a Percussion Cap and Cartridge Manufactory where the current Plot 2 and Plot 3 buildings are situated, and later labelled an Ammunition Manufactory on maps from 1895-1896. Trinity church was present to the south where the current St. Andrew's Gardens and Trinity Court Residences are. To the north of the site was a Builders Yard. A timber yard was later present to the north of the site and in sections of the Plot 3 boundary.

A flying bomb impacted the southeast of Plot 1 in 1944; this building section was later redeveloped and known to be founded on piles and adjoins to the Plot 3 Levy Wing following the bomb damage. The Eastman Dental Clinic is present by 1946. By the 1980's to 90's the southern "New Wing" is constructed with other sections refurbished.

The surrounding area is initially known to be predominantly residential terraced housing with some industrial land use including Builders Yards, timber yards, foundry, brewery, and railways and tramways. By 1953 a clothing factory, engineering works, paint and printing ink factory are noted near the site. Around this time the Foundling Hospital and Trinity Church located nearby were demolished. By the 1980's industrial warehouses directly to the north of the site were converted into residential developments. The park where the Calthorpe project currently is, was present by this time also. The UCL Frances Gardner house building was constructed in 2003.

EXECUTIVE SUMMARY

Report Content

The information in this document makes reference to a number of other documents prepared by Ramboll or the wider project team. These include;

- A Desk Top Site Appraisal including site history, utilities, and existing buildings and structures.
- Summary of the site information including geology, hydrogeology, and hydrology.
- Appraisal of the existing structure as it relates to the works and the final proposal.
- Illustrative and quantitative details of the proposed structure to be further developed in the Detailed Design Phase.
- Outline construction sequence to be further developed by the Contractor.
- Predicted ground movements, discussion of the implications and proposed mitigations.

The document should be read in conjunction with:

- The proposed Architectural planning drawings, by Hawkins/Brown.
- Results of the utilities survey.
- Flood Risk Assessment Report by Ramboll.
- Historic Environment Desk Based Assessment, Pre-Construct Archaeology, April 2018.
- Initial Heritage Assessment, Alan Baxter, February 2018.
- Movement Monitoring Strategy, Ramboll, October 2018.

Summary of the Impact Assessment

Screening	The proposed basement extends beneath the water table surface. A flood risk assessment was carried out by Ramboll, it indicates the site is in Zone 1 of the EA (Environment Agency) flood risk map, and there is a low risk of flooding from surface water drainage and other man-made sources. The proposed basement will be found on London Clay. The Envirocheck Report indicates a moderate potential for shrinking or swelling clay ground stability hazards on site. A ground investigation has been completed for the neighbouring Plot 1 site in 2018. It indicates that the ground water level is variable but that the proposed Plot 3 basement formation level is likely to be above the ground water level. The groundwater level is particularly low in this area partially due to the higher level of the London Clay encountered and the relatively minor extent of the River Terrace Deposits on the site. The London Clay is classified as an unproductive stratum, however during the excavation, limited volumes of perched groundwater above the London Clay and within Made Ground / River Terrace Deposits may be encountered and as a result, temporary dewatering may be required. Based on the ground conditions encountered from the ground investigation on the adjacent site, it is inferred that Plot 3 appears to be situated on a localised high geological point for the London Clay from geological folding. Groundwater flows in the near surface minor aquifer would tend to be away and/or around the site, therefore the risk for planning and the substructure impact is low. This will be confirmed upon completion of the site-specific investigation for Plot 3. The proposed basement will increase differential depth of foundations to neighbouring properties, especially the Eastman Dental Clinic, and will need to be designed to ensure the stability of the site and any potentially sensitive structures that are significantly influenced by development of the site.
Scoping	Consideration has been given to the impact of the proposed development on groundwater flow, land stability and surface water flows. Issues and proposed mitigation measures are summarised below: The construction of the proposed redevelopment of the UCL site could lead to minor focussing of surface run off waters, and greater interception levels increasing the total amount of surface run off. This issue will be mitigated by utilising a sustainable urban drainage system which will lead to an overall betterment of the surface water run-off rate from the site, reducing the downstream flood risk. Proposed options at the time of writing this report can be found within the Drainage Philosophy. The site is underlain by London Clay which has a high-volume change potential. Given the nature of the ground conditions, provision for heave mitigation will be considered within the foundation design, during the detailed design stage.
Ground Movement and Damage Assessment	The proposed basement site is in the close proximity to a number of surrounding structures including the Grade II Listed Eastman Dental Clinic; therefore, it is envisaged that appropriate propping and temporary works would be installed during the basement construction to limit the effect of ground movements to the surrounding properties. Based on the assumed construction methodology, ground movements have been calculated at the nearby building locations and the resultant damage assessment based on CIRIA C760 methodology has been undertaken. This assessment has been undertaken assuming both Plot 1 and Plot 3 basements are undertaken during the same construction phase. Generally, the movement derived damage predicted falls between Category 0 (Negligible) and Category 1 (Very Slight) based on typical damage categories for masonry buildings and the corresponding tensile strains based on Burland et al. (1977) and Boscardin and Cording (1989) categorisation. For structures directly adjacent to and bounding the proposed contiguous pile retaining wall boundary line, a damage Category of 1 has been estimated. The influence of the Plot 3 basement extension does increase the magnitude of displacement and strains however does not increase the overall damage Category to unacceptable levels. It is recommended that movement monitoring is carried out on the structures that have been calculated to be within Damage Category 1 prior to and during the proposed basement construction. It should be noted that the existing retaining wall bounding the north of the site, the east of the site where the current car park is located and parallel to Seddon Street will be demolished over the majority of the length, therefore is not considered wthin the ground movement assessment calculations.

EXECUTIVE SUMMARY

Conclusions

Based on the work undertaken as outlined within this report through conservative modelling of the basement construction, the impact of the basement construction on surrounding structures can be mitigated through design and construction methods.

Consideration has been given to the impact of the proposed development on groundwater flow, land stability and surface water flows. Residual risks were shown to be present and the design implications associated have been discussed in the Scoping section (Section 5).

There are no major concerns relating to subterranean groundwater flow, surface flow and flooding, and slope stability.

On the basis of the assumed construction methods and sequence, a ground movement assessment has been undertaken for the proposed development. It confirms that ground movements could affect the surrounding structures, and any damage to neighbouring assets can be limited to 'Very Slight' (Burland Category 1).

To ensure the movements remain within acceptable limits, movement monitoring has been proposed. The Contractor will be required to carry out detailed monitoring of the surrounding properties to record ground movements and take appropriate action should the movement not be as expected.

The final construction sequence will be developed to take account of limitations established during the detailed design phase. Should the contractor propose to carry out the works in a different sequence to that assumed in our design then a further assessment of the predicted movement will be required, and the proposal only accepted if there is no significant change to the scale of predicted movement.

A Draft Construction Management Plan (CMP) has been developed by the project advisor which will include the scope of the monitoring requirements set out in the Ramboll movement monitoring strategy. A monitoring action plan for various stages of the project can be considered to monitor the existing structure and foundations, new walls and foundations and the adjacent Grade II Listed buildings. Trigger levels should also be set prior to construction phase to identify limits on monitored results and to define actions and mitigation measures if these limits are reached and/or exceeded. The traffic light approach could be adopted with green, amber, and red trigger levels set.

The following next steps can be undertaken as the design of the site is further developed;

- Construction methods are developed with the Contractor to feed into the ground movement analysis once the sequence of works is developed. To include for best practice control methods during piling including but not limited to 'hit one, miss three' approach and good quality workmanship;
- A pre and post works condition survey to be undertaken in relation to potentially affected surrounding properties and assets;
- Approval in Principle (AiP's) for the temporary and permanent basement construction is required from LB Camden Highways due to the proximity to TfL road networks, namely Grays Inn Road;
- Given the setting of the site and the derived Low to Medium Risk, it is recommended that consideration should be given to the potential risks to any below ground works posed by UXOs in accordance with CIRIA C681. Contractors to consider UXO mitigation during probing, intrusive investigation, piling and excavation works;
- Undertake detailed foundation and retaining wall analyses and design;
- Completion of the Specification for Piling and Embedded Retaining Walls and further consultation with specialist contractors;
- Completion of the Plot 3 site-specific Site Invesitgation scoped;
- Agreement through the Planning application process from London Borough of Camden on the proposed methodologies and analysis within the BIA.

1. INTRODUCTION

1.1. Brief

This Basement Impact Assessment (BIA) has been prepared by Ramboll UK in connection with the proposed refurbishment and redevelopment of 256 Grays Inn Road to deliver a new world-leading dementia and neurology research centre, as well as additional academic floorspace for University College London.

The proposed development includes the construction of a new research building to house the UCL Institute of Neurology and Dementia Research Institute (IoN/DRI).

This document describes the anticipated combined Plot 1 and 3 basement impact on the surrounding area, which includes a multi-storey Grade II Listed building, the Eastman Dental Clinic (EDC).

This document presents information regarding the current understanding of the site, describes the recommended structural options for the basement and discusses some of the potential risks and opportunities associated with the proposal.

Various assumptions have been made in the design, these are stated in relevant sections of text. These will be reviewed by the project team and agreed prior to moving to the detailed design stage.

1.2. Scope

The main part of the site occupied by the Eastman Dental Hospital, was vacated and relocated to a new development at Huntley Street in 2019. The Eastman Dental Hospital is made up of a group of buildings comprising:

- the former Royal Free Hospital (Plot 1)
- the grade II listed Eastman Dental Clinic (Plot 2); and
- the Levy Wing (Plot 3).

The redevelopment is currently planned to take place in three phases;

- Phase 1; post partial demolition of the former Royal Free Hospital (RFH) and complete demolition of the Levy Wing and infill building between the RFH and EDC, this phase comprises the full delivery of the Plot 1, partial enhancement works to EDC, relocation of the Memorial Fountain and partial delivery of external landscape works. This report summarises the condition where Plot 3 basement is completed to ground level in-line with the full delivery of Plot 1.
- Phase 2; Restoration to the full façade of the EDC and internal modifications.
- Phase 3; Construction and delivery of Plot 3, and completion of proposed external landscape works, where the Plot 3 building superstructure is to be completed.

The scope of this BIA covers the basements for Phase 1 and 3 works. The proposed basement on Plot 1 is covered in BEMP-RAM-P1-XX-RP-CG-00-0018 as part of this application.

1.3. London Borough of Camden Requirements

In line with LBC planning policy, a BIA is required for planning applications to demonstrate that the scheme:

a. Maintains the structural stability of the building and neighbouring properties;

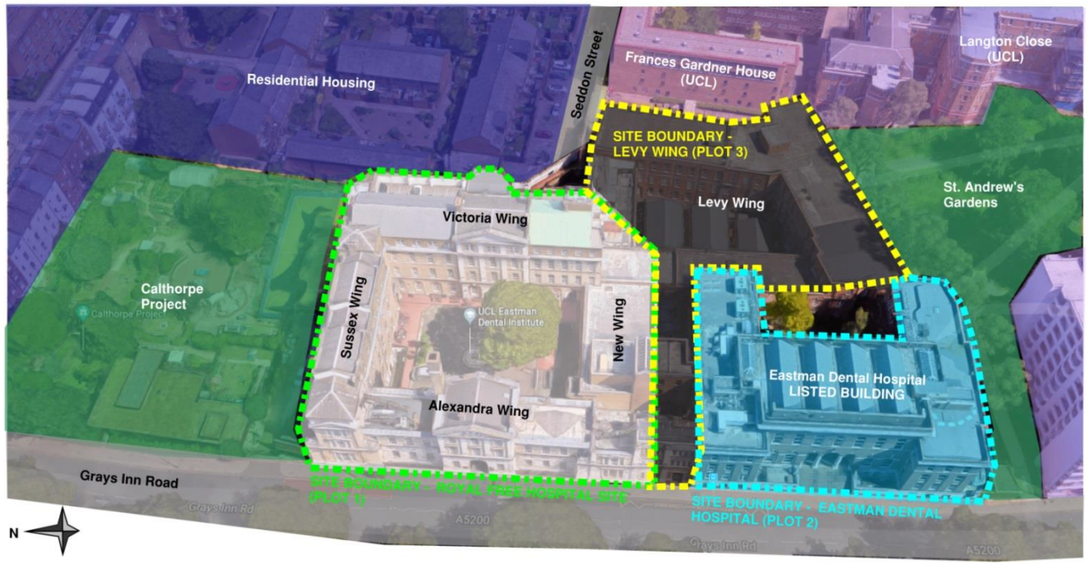
b. Avoids adversely affecting drainage and run off or causing other damage to the water environment; and,

c. Avoids cumulative impacts upon structural stability or the water environment in the local area.

The purpose of this report is to evaluate the impacts of the proposed basement considering the issues of hydrology, hydrogeology, and land stability through a staged methodology. This report has been structured to follow through the incremental stages of:

- Screening (Section 4)
- Scoping (Section 5)
- Ground Movement Assessment (Section 9)

This report considers the full screening, scoping, and basement impact assessment stages. It relies upon readily available desk study information, an intrusive ground investigation carried out in May - July 2018, supplementary



investigative works undertaken in February and August 2020, and publicly available information to identify and appraise the nature and magnitude of potential impacts, together with appropriate mitigation measures. It is intended that this document supports the application of UCL in gaining planning permission for the development. A site-specific ground investigation has been scoped for Plot 3, with dates of mobilisation to be confirmed.

Figure 1: Site Plot Division

1.4. Supporting Documents

This report forms part of the submission of the application for planning permission and listed building consent and should be read in conjunction with the Geotechnical Desk Study prepared by Ramboll (BEMP-RAM-SW-XX-RP-CG-00-0014).

2. SITE DESCRIPTION

2.1. Site description and layout

The application site at 256 Grays Inn Road is 1.207ha in area, and is bounded to the west by Grays Inn Road, to the north by the Calthorpe Project and the New Calthorpe Estate, to the east by Langton Close, and to the south by Trinity Court and St Andrew's Gardens. The main part of the site occupied by the Eastman Dental Hospital, was vacated and relocated to a new development at Huntley Street in 2019. The Eastman Dental Hospital is made up of a group of buildings comprising:

- the former Royal Free Hospital (Plot 1)
- the grade II listed Eastman Dental Clinic (Plot 2); and
- the Levy Wing (Plot 3).

The rear part of the application site includes the existing student accommodation at Frances Gardner House.

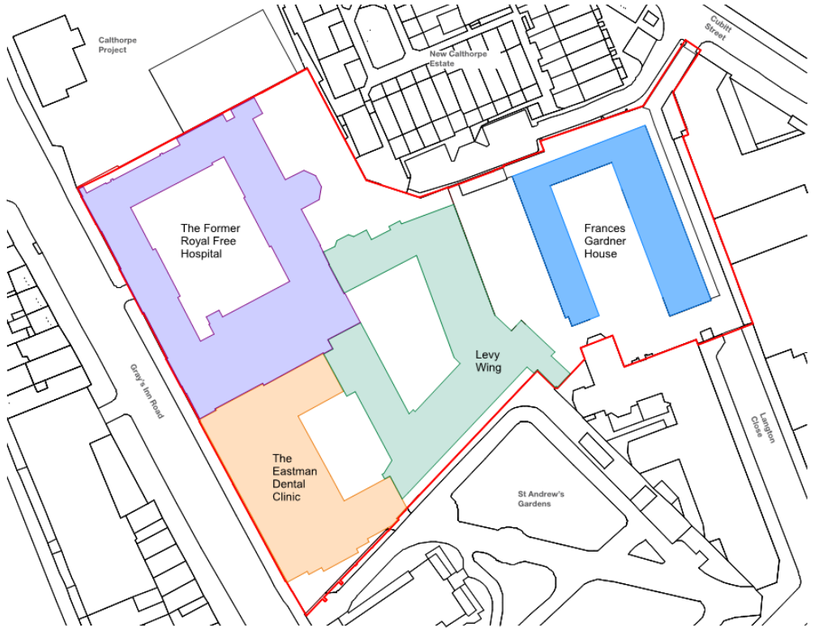


Figure 2: Site Plan Identifying Existing Buildings

2.2. Surrounding Land-Use

Grays Inn Road borders the site along the entire western boundary with commercial and residential properties the other side of the road. Beyond these is Mecklenburgh Street which runs parallel to Grays Inn Road, numbers 1-8 Mecklenburgh Street are Grade II Listed five-storey buildings. To the north of the site is the Calthorpe Project a community garden and centre. To the northeast is residential housing, to the south east is the approximately five-storey Frances Gardner House owned by UCL. Seddon Street runs perpendicular to the site between the residential housing and Frances Gardner House. To the south of Plot 2 and 3 is St. Andrew's Gardens, and Trinity Court a nine-storey residential apartment building.

Plot 3 comprises the Levy Wing which represents the newest built structures on site, forming a court yard with three mobile structures in the centre. Further background information can be found within the Architectural information supporting the Planning Application. At the time of writing the report, Plot 3 was being demolished in its entirety.

Plot 1 contains the Royal Free Hospital that comprises four wings around a central courtyard containing a Grade II Listed fountain and large tree. The Alexandra Wing on the west side fronts onto Grays Inn Road. The Sussex Wing forms the northern border of the site. The Victoria Wing is in the north east of the site with a small asphalt car park area beyond it next to the eastern site boundary. The New Wing forms the south east border of the courtyard and backs onto the Levy Wing of Plot 3.

2.3. Proposed development

Planning permission 2019/2879/P was granted in March 2020 for the redevelopment of 256 Grays Inn Road to provide a dementia and neurology research centre along with academic space for University College London (UCL). This BIA has been prepared by Ramboll in connection with the planning application to amend the above permission to extend the basement of the new academic building, known as Plot 3.

The first phase of the proposed development comprises the partial redevelopment of the former Royal Free Hospital (Plot 1) to deliver a world-leading medical research facility to tackle dementia and neurological diseases such as:

- Alzheimer's Disease;
- Multiple Sclerosis;
- Huntington's Disease;
- Parkinson's Disease;
- Motor Neurone Disease;
- Stroke; and
- Epilepsy.

Work on site is currently underway on Plot 1. The new dementia and neurology research facility would host the central hub of UK Dementia Research Institute (DRI) and University College London's Queen Square Institute of Neurology (IoN), alongside related neurological NHS outpatient services provided by University College London Hospitals NHS Foundation Trust. The project is rooted in central government's 2020 Challenge on Dementia and is backed by the Medical Research Council, Alzheimer's Research UK and the Alzheimer's Society. The aim is to provide the most comprehensive, coordinated neuroscience research centre in the world, from research at laboratory benches to patient care. The new research centre is collectively referred to as the IoN/DRI.

Subsequent phases of the approved development comprise the refurbishment of the grade II listed Eastman Dental Clinic and the erection of a new building on the site of the Levy Wing to deliver additional academic space for UCL. This academic space is will complement the University's vision for creating a world class environment for education and academic research. The proposed development would also deliver a comprehensive landscaping scheme to open up new publicly accessible spaces within the site, and new public connections across it.

This planning application relates to the proposal to extend the basement of the Plot 3 building underneath the public realm area in the centre of the site to provide two lecture theatres for the academic use. UCL has identified a requirement for larger lecture theatres than would be delivered in the approved scheme. It also reflects UCL's intention to bring the delivery of the Plot 3 basement works forward at the same time as the Plot 1 basement works to deliver the development in a more efficient and less disruptive way.

This planning application also proposes small extensions to the basement of the Plot 1 building to allow for the provision of a sprinkler tank and additional plant.

This report supercedes the Plot 3 BIA submitted in August 2019 submitted with the original planning application and sets out how the proposed amendments affect the detail and conclusions of the original report. This report should be read in conjunction with the original report.

The proposed development for Plot 1 comprises the demolition of the Sussex, Victoria and New Wings, and the construction of a 9-storey development; this comprises a 2-storey basement (approximately 9m below existing Plot 1 basement level and 14m bgl) and a 7-storey superstructure, inclusive of 2-storeys for plant. Plot 1 also comprises an extension of the Plot 1 basement in the southeast corner, in order to house a sprinkler tank at B2 level, and the southwest corner to house additional plant.

The proposed development for Plot 3 comprises the demoltion of the Levy Wing, and the construction of a 4-to-7-to-4-storey development above ground and a 2-storey basement (approximately 8m bgl and shallower than Plot 1), where Plot 1 and 3 basements are planned to adjoin.

Only minor works are proposed to the existing student accommodation at Frances Gardner House, comprising the installation of photovoltaic panels on the roof, and alterations to the landscaping within the courtyard.

In summary, the partial redevelopment of Eastman Dental Hospital comprises:

a. Within the former Royal Free Hospital (Plot 1), the demolition of the New, Sussex and Victoria Wings and the retention of the Alexandra Wing, with a single storey upward extension and reinstatement of the southern pediment on the Alexandra Wing, and the erection of a five storey building (plus two storeys of plant above and two storey basement below) to the rear of the Alexandra Wing to provide a dementia and neurology research facility (Use Class D1);

b. Alterations to the Grade II listed Eastman Dental Clinic (Plot 2), including the part rebuilding of the northern façade, replacement of windows, and internal alterations associated with its conversion to education use (Use Class D1);

c. The demolition of the Levy Wing (Plot 3) and erection of a part 4 storey, part 7 storey building (plus two storey basement below) to provide education space (Use Class D1);

d. The relocation of the Grade II listed Riddell Memorial Fountain from the courtyard of the former Royal Free Hospital to the courtyard of the Eastman Dental Clinic;

e. The installation of photovoltaic panels on the roof of Frances Gardner House;

f. Associated landscaping arrangements including the creation of a new public square and pedestrian connections to St Andrew's Gardens, Cubitt Street and Langton Close;

g. Associated access, servicing, landscaping, and parking arrangements.

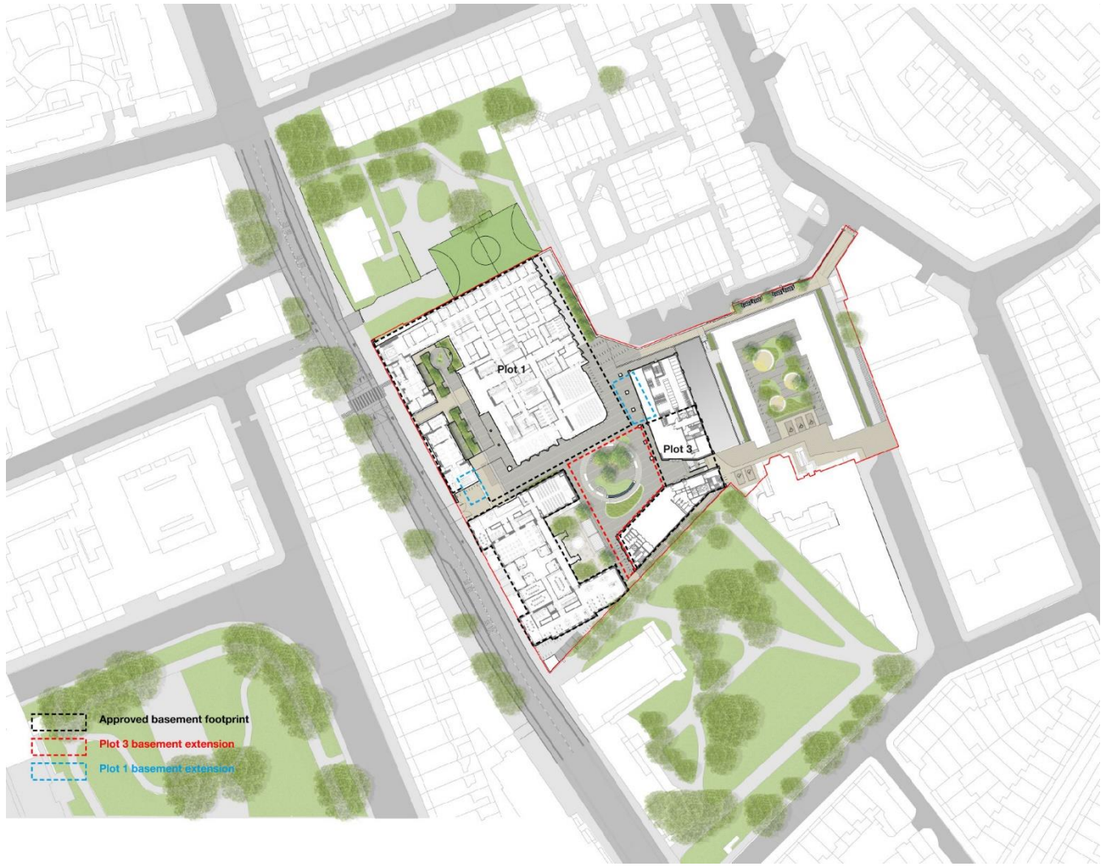


Figure 3: Site Plan Identifying Plots

3. ENVIRONMENTAL SETTING

3.1. Geology

The site geology and environmental setting is fully detailed in Ramboll's Geotechnical and Geoenvironmental Desk Study Report and Ground Investigation Report which should be referred to. A summary is provided below.

Based on the Plot 1 ground investigation data and the British Geological Sheet for the area (Sheet 256, North London 1:50000 Geological Survey of England and Wales), the stratigraphy comprises Made Ground over superficial deposits of Alluvium and River Terrace Deposits of variable extent. The solid geology consists of London Clay (with a weathered upper section), Lambeth Group, Thanet Sand, and the Upper Chalk.

A summary of the stratigraphy encountered can be seen in Table 3.1.

The Envirocheck report indicates a moderate potential for shrinkage or swelling clay ground stability hazard on site this will be associated with the London Clay.

These ground conditions will be confirmed during a Plot 3 site-specific ground investigation – this has been scoped and due for mobilisation in November/December 2020. The exploratory hole location plan is shown in Figure 4. Information will be summarised within a Site Investigation Report specific to Plot 3, which will consider the potential change in ground conditions or ground variability.

Table 3.1: Summary of Site Stratigraphy

Stratum		Elevation at Top of Stratum (m AOD)	Thickness (m)	Exploratory Holes from Plot 1 GI where Stratum Encountered
Stratum		Elevation at Top of Stratum (m AOD)	Thickness (m)	Exploratory Holes from Plot 1 GI where Stratum Encountered
Made Ground		+20.56 – +16.35	4.70 to 0.70	All
River Terrace Deposits		+18.06 - +16.87	2.00 to 0.25	BH02C, WS02, TP09
Weathered London Clay		+18.14 - +15.81	5.20 to 1.90	BH01, BH02A, BH02C, BH03, BH04, WS01, WS02, WS03, OP01
London Clay		+13.95 – +12.43	14.20 to 12.70	BH0, BH02C, BH03, BH04, WS01, WS02, WS03,
Lambeth Group	Upper Mottled Beds	+0.01 - -0.76	7.18 to 6.10	BH01, BH02C, BH03, BH04
	Laminated Beds	-6.44 - -7.45	2.70 to 0.50	BH01, BH02C, BH03, BH04
	Lower Mottled Beds	-6.94 – -9.56	7.50 to 5.20	BH01, BH02C, BH03, BH04
	Mottled Upnor Formation	-13.57 - -15.56	3.70 to 1.63	BH01, BH02C, BH04
	Upnor Formation	-13.29 - -18.56	5.40 to 1.00	BH01, BH02C, BH03, BH04
Thanet Sands		-19.56 - -20.57	4.90 to 3.00	BH01, BH02C, BH04
Chalk Formation		-22.99 - -24.46	Base not proven	BH01, BH02C, BH03, BH04

3.2. Topography

A topographic survey for the site has been completed by Gleeds Building Surveying Ltd. It indicates the ground is generally level across the site, with existing elevations of approximately +20.5m above Ordnance Datum (AOD) observed. There is an evident reduction in elevation between the boundary between Plot 1 and Plot 3 i.e. the adjacent land between the parking area and Levy Wing, where the elevation reduces to approximately +17.0m AOD to +18.0m AOD.

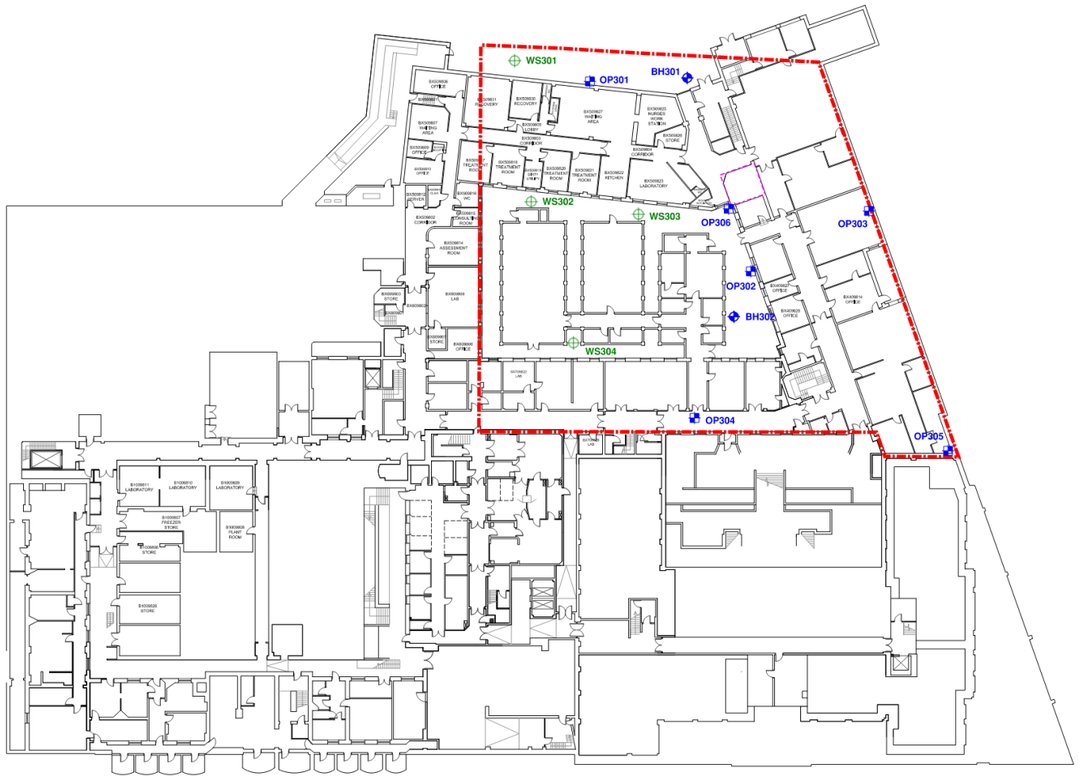


Figure 4: Exploratory Hole Location Plan for Plot 3 Site Investigation

3.3. Hydrogeology and Hydrology

The hydrogeology is divided into two units comprising an upper Secondary Aquifer, which is primarily formed by an unsubstantial layer of River Terrace Deposits, and a lower aquifer which is primarily formed below the London Clay and Lambeth Group, comprising the Thanet Sands and Upper Chalk, which are classified as Principal Aquifers. During the drilling for the ground investigation on Plot 1, no water strikes were encountered in either shallow or lower aquifers.

Evidence from the Plot 1 ground investigations show this shallow aquifer is thin and absent in places and no groundwater strikes were encountered during drilling. The London Clay is also reasonably elevated at the site and proven to be of low permeability. Therefore, the basement will only be constructed within a thin inconsistent shallow aquifer and mostly in the low permeability strata of the London Clay. Groundwater within strata beneath the London Clay is confined and likely to have a potentiometric surface (water level) that rises up (e.g. not too dissimilar to an artesian well). However the basement will not be excavated into aquifers beneath the London Clay (i.e. this deeper groundwater will not be encountered). Overall, the basement is not considered to have a significant impact on the local shallow hydrogeology mainly due to the absence of a plausible shallow aquifer beneath the site.

With reference to the Plot 1 ground investigation, 1no. Falling Head Test was carried out in BH04 during drilling between 3.00m bgl and 12.02m bgl, targeting the weathered London Clay and the unweathered London Clay, confirming the very low permeability of the clay as $4.84e^{-9}$m/s (0.0004m/day).

Rest groundwater levels were recorded in monitoring wells and piezometers installed during the ground investigation. Using the data from 5No. ground gas/groundwater monitoring standpipes, 4No. standpipe piezometers, and 4No. vibrating wire piezometers, it has been interpreted that a groundwater level of approximately +9.4m AOD is estimated for the global Plot 1 site. This water level is considered to represent the

piezometric surface, not a water table in the shallow aquifer. At this level however, the groundwater profile is below hydrostatic pressure conditions, gradually draining through the London Clay and Lambeth Group to the Chalk. For the lower aquifer the data indicates that the groundwater elevation is in hydrostatic conditions at -30m AOD which is below the top of the Chalk and matches well with published Environment Agency (EA Annual Report Summary) data.

The River Thames is situated approximately 1.75km south of the site. The Regent's Canal system is located to the north, with the closest point approximately 935m away from the site. The River Fleet Relief sewer is subterranean culverted watercourse passing adjacent to the site beneath Grays Inn Road.

Based on the ground conditions encountered from the Plot 1 ground investigation in proximity to Plot 3, the site appears to be situated on a localised high geological point for the London Clay from geological folding. Groundwater flows in the near surface minor aquifer would tend to be away and/or around the site, therefore the impact risk of the proposed development is considered **low**. The site-specific ground investigation scoped for Plot 3 will be used to verify and consolidate this information.

3.4. Flooding

A flood risk assessment has been undertaken by Ramboll. The EA's flood map data shows the site to be located within Flood Zone 1, indicating the site has a less than 0.1% annual probability of river or sea flooding in any year. The flood risk from surface water and drainage, groundwater, reservoirs, canals and other artificial sources is considered to be low. The Camden Flood Risk maps put it in a "critical drainage area" but outside "local flood risk zones".

3.5. Site History

From the second half of the 19th century the Royal Free Hospital was present, with a percussion cap and cartridge manufactory present on Plot 2 and Plot 3. Trinity church was present to the south on the site of the current St. Andrew's Gardens and Trinity Court Residences. To the north of the site was a Builders Yard. A timber yard was later present to the north of the site and in sections of the Plot 3 boundary.

A flying bomb impacted the southeast of Plot 1 in 1944; this building section was later redeveloped and known to be founded on piles and adjoins to the Levy Wing following the bomb damage. The Eastman Dental Clinic is present by 1946. By the 1980's to 90's the southern "New Wing" is constructed with other sections refurbished.

Since the earliest sourced historic map from 1874, the surrounding area is initially known to be predominantly residential terraced housing with some industrial land use including Builders Yards, timber yards, foundry, brewery, and railways and tramways. By 1953 a clothing factory, engineering works, paint and printing ink factory are noted near the site. Around this time the Foundling Hospital and Trinity Church located nearby were demolished. By the 1980's industrial warehouses directly to the north of the site were converted into residential developments. The park where the Calthorpe project currently is was present by this time also. The UCL Frances Gardner house building was constructed in 2003.

3.6. Tree Information

The courtyard at the centre of Plot 1 hosts a fully-grown tree towards the south which is proposed to be removed.

The site lies in the Bloomsbury conservation area and as such all trees are subject to a blanket protection order. An arboriculture report has been commissioned to assess the value of the existing trees on the site.

The contiguous pile wall on the southern side of the Plot 3 proposed excavation will likely be within the tree protection zone of the trees lining the western edge of St. Andrew's Gardens.

3.7. Underground Services

A Landmark utilities report has been completed for the site. It found the majority of utilities are below Grays Inn Road with some feeding the site. They include electricity and telecoms line, gas pipes, and water/sewerage pipes.

Thames Water assets comprising a 4" cast iron distribution main, a 16" concrete trunk main, a brick arch sewer and a deep brick lined storm relief sewer are known to run beneath Grays Inn Road, a minimum of 9m west of the outer retaining wall boundary of site. Additional information is included in the qualitative Thames Water Assessment (BEMP-RAM-P1-XX-TN-CG-00-0001).

4. SCREENING

An initial screening exercise has been undertaken in relation to Subterranean Flow (Table 4.1), Slope Stability (Table 4.2), and Surface Flow and Flooding (Table 4.3). The following appraisal is based on the proposed new basement construction, the extent of which is indicated on the project drawings.

The screening exercise is based on the ground model identified in the Ground Investigation Report (GIR) for Plot 1 (Report no. BEMP-RAM-P1-XX-RP-CG-00-0015) and summarised in Section 4 of this report. This will be updated post undertaking a site-specific Site Investigation and GIR for Plot 3.

Table 4.1: Screening of Subterranean Flow

Number	Question	Answer	Comments
1a	Is the site located directly above an aquifer	Yes	The site is underlain by Made Ground over an inconsistent layer of River Terrace Deposits which are classed as a Secondary A Aquifer by EA designations.
1b	If yes to 1a), will the proposed basement extend beneath the water table surface?	Yes	Groundwater level is anticipated to be at approximately +9.4m AOD. This is a piezometric surface, not a water table in the shallow aquifer. The proposed Plot 3 basement foundation level is approximately +11.5m AOD. The proposed Plot 1 basement foundation level is +7.8m AOD (top of raft) with formation level varying between +5.8m AOD to +6.5m AOD.
2	Is the site within 100m of a watercourse, well (used/disused) or potential spring line?	No	No watercourses are within 100m, however the culverted River Fleet Relief Sewer is located 10m to the west of the site.
3	Will the proposed basement development result in a change in the proportion of hard surfaced/paved areas?	No	There will be an increase in built footprint as a result of the development however there will be no increase in impermeable areas as the existing site is almost entirely hardstanding.
4	As part of the site drainage, will more surface water (e.g. rainfall and run-off) than at present be discharged to the ground (e.g. via soakaways and/or Sustainable Urban Drainage?)	No	A Drainage Strategy has been prepared by Ramboll that will reduce the current surface water discharge using a sustainable urban drainage system, and agreed with the LLFA.
5	Is the lowest point of the proposed excavation (allowing for any drainage and foundation space under the basement floor) close to, or lower than, the mean water level in any local pond or spring line.	No	No such features are present within 100m of the site, as discussed in Question 2 above.

Table 4.2: Screening of Slope Stability

Number	Question	Answer	Comments
1	Does the existing site include slopes, natural or manmade, greater than 7°?	No	The site of the basement is covered by a topographic map. It shows that there is no slope greater than 7°, with the elevation staying between +17.00m AOD and +18.00m AOD for the majority of the Plot 3 site and +20.00m AOD and +21.00m AOD for the Plot 1 site.
2	Will the proposed re-profiling of the landscape at the site change slopes at the property boundary to more than 7°?	No	The current plans detailed in the planning documents do not indicate landscape reprofiling.
3	Does the development neighbour land, including railway cuttings and the like, which slopes greater than 7°?	No	The development does not neighbour any railway cuttings or sites with slopes greater than 7°.
4	Is the site in a wider hillside setting with a slope of more than 7°?	No	Ordnance Survey maps do not show a hillside setting to the site.
5	Is the London Clay the shallowest strata at this site?	Yes	The shallowest strata is London Clay in areas of the site where Alluvium or River Terrace Deposits are not present.
6	Will any tree(s) be felled as part of the proposed development and/or any works proposed within any tree protection zones where trees are to be retained?	Yes	No trees are present in the Plot 3 area but piling will occur adjacent to the tree protection area of trees bordering St. Andrew's Gardens to the east of Plot 3 which are to be retained. The project arboriculturalist has advised that the piling is not anticipated to have an impact on the root protection zones. No trees are to be felled as part of the proposed development. Detailed discussions with the tree officer have been taking place in relation to these trees. The mature tree within the Plot 1 courtyard will be felled in order to enable the construction of the basement.
7	Is there a history of shrink-swell subsidence in the local area, and/or evidence of such effects at the site?	Yes	The Envirocheck Report indicates a moderate potential for shrinking or swelling clay ground stability hazards on site.
8	Is the site within 100m of a watercourse or potential spring line?	No	Refer to Question 2 in Table 4.1
9	Is the site in an area of previously worked ground?	No	By reference to online BGS Geology maps the site is not in an area of recorded worked ground. However, the ground investigation revealed Made Ground to be present to an average depth 3.1m bgl, which is assumed to be consistent over Plot 3 prior to a site-specific ground investigation – this will be confirmed during a site-specific SI.
10	Is the site within an aquifer? If so, will the proposed basement extend beneath the water table such that dewatering may be required during construction?	Likely (Plot dependent)	Anticipated groundwater level is approximately +9.4m AOD vs a proposed Plot 3 basement formation level of approximately +11.5m OD and Plot 1 basement formation level of +6.5m OD. It should be noted that the anticipated maximum retaining wall toe level for both Plots 1 and 3 is considered to be approximately -4m AOD. There were no recorded water strikes in the exploratory holes during the ground investigation. Perched water was

Number	Question	Answer	Comments
			subsequently detected in shallow wells. The pore water pressure was also interpreted to be below hydrostatic indicating it was draining below through the London Clay and Lambeth Group into the Upper Chalk. London Clay, was found to have a low permeability thus the risk of flooding during excavation is low. The development may however encounter limited volumes of perched groundwater in the strata above the London Clay, and as a result temporary dewatering may be required.
11	Is the site within 50m of highway or pedestrian right of way?	Yes	Ordnance Survey maps indicate that the Plot 3 site is within 50m of Grays Inn Road, Seddon Street, Mecklenburgh Street, and Heathcote Street. Plot 1 is within 50m of Grays Inn Road, Seddon Street, and Langton Close.
12	Will the proposed basement significantly increase the differential depth of the foundations relative to neighbouring properties?	Yes	There will be an increase in differential depth between the Plot 1 and 3 basements and the ground floor of Eastman Dental Clinic.
13	Is the site over or within the exclusion zone of any tunnels.	No	The Metropolitan Railway (Clerkenwell cut-and-cover tunnel) runs in a southeasterly direction, from King's Cross to Farringdon Station within 250m east of the site. The nearest London Underground tunnel is the Hammersmith and City Line approximately 200m away from the closest section of the proposed site boundary. The site is outside the exclusion zone. Kingsway Tram Tunnel is noted to be >800m away from the site and is outside the exclusion zone. The Royal Mail Tunnels are understood to be located south of the site, with the postal museum and depot approximately 250m and outside the exclusion zone.

Table 4.3: Screening of Surface Flow and Flooding

Number	Question	Answer	Comments
1	As part of the proposed site drainage, will surface water flows (e.g. volume of rainfall and peak run-off) be materially changed from the existing route?	Yes	Refer to Question 4, Table 4.1. The route will not change and will continue to be discharged to the Thames Water sewer system. The rate of flow will change.
2	Will the proposed basement development result in a change in the proportion of hard surface/paved external areas?	No	Refer to Question 3, Table 4.1.
3	Will the proposed basement result in changes to the profile of the inflows (instantaneous and long term) of surface water being received by adjacent properties or downstream water courses?	Yes	The installation of a sustainable drainage system for the plot will affect the profile of inflows of surface water being received by adjacent properties or watercourses. All surface water discharge will be via the local sewer system.
4	Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream water courses?	No	The site is not envisaged to provide any additional surface water pollution. The water quality may improve following the installation of a sustainable drainage system with treatment stages.
5	Is the site in an area known to be at risk from surface water flooding, or is it at risk from flooding, for example because the proposed basement is below the static water level of a nearby surface water level of a nearby surface water features?	No	The Flood Risk Assessment states that the site is at low risk of surface water flooding. There are no nearby surface water features.

5. SCOPING

The scoping stage considers the steps necessary to assess the impact of the issues identified during the screening phase. Table 5.1 below reviews those issues and addresses the potential impacts and necessary actions to mitigate these issues.

Table 5.1: Scoping of the Issues Identified in the Screening Stage

Table and question number	Question	Potential Impact and Actions
4.1 – 1a	Is the site located directly above an aquifer?	**Potential Impact:** Groundwater flooding. Given the low permeability of the London Clay and the thickness and limited extent of the River Terrace Deposits it is likely to be from perched groundwater, if any. **Actions:** Dewatering may be required during construction. Groundwater level is anticipated to be at approximately +9.4m AOD. The proposed Plot 3 basement foundation level is approximately +11.5m AOD. The effects of groundwater are not of critical concern for Plot 3. This will be verified through a site-specific ground investigation. The proposed Plot 1 basement formation level is approximately +6.5m OD. Limit contamination pathways if groundwater encountered. Basement construction for both Plots comprises a full contiguous pile box extending into the London Clay and providing a barrier to water ingress.
4.1 – 1b	If yes to 1a), will the proposed basement extend beneath the water table surface?	**Potential Impact:** Groundwater flooding. As above. **Actions:** Dewatering. As above.
4.2 - 5	Is the London Clay the shallowest strata at this site?	**Potential Impact:** Could cause shrink – swell subsidence in the area. **Actions:** Take this into account when designing the foundations of the structure.
4.2 – 6	Will any tree(s) be felled as part of the proposed development and/or any works proposed within any tree protection zones where trees are to be retained?	**Potential Impact**: Damage to and possible death of neighbouring trees. **Actions:** Complete an arboricultural method statement and tree survey. Assess the zone of influence of trees and propose construction methods to mitigate against impact.
4.2 - 7	Is there a history of shrink-swell subsidence in the local area, and/or evidence of such effects at the site?	**Potential Impact:** The site is underlain by London Clay which has a high volume change potential. **Actions:** Take this into account when designing the foundations of the structure.
4.2 - 10	Is the site within an aquifer? If so, will the proposed basement extend beneath the water table such that dewatering may be required during construction?	**Potential Impacts:** Flooding of the excavation. **Actions:** Dewatering may be required if perched groundwater is encountered. The low permeability of the London Clay means waterproofing is unlikely to be necessary.
4.2 - 11	Is the site within 50m of highway or pedestrian right of way?	**Potential Impacts:** The construction of a basement can result in ground movements detrimental to roads and any infrastructure contained therein such as is known to exist beneath Grays Inn Road or Seddon Street. The site is in proximity to Langton Close. Health and safety risk to members of the public. **Actions:** The owners of these assets, along with the owner of the highway, should be consulted to determine any constraints to design, for example, easements, surcharge loadings on the basement walls and limiting values on ground movement. Such matters will need to be considered in the design of the basement and another estimate of likely ground movement and damage caused made during the detailed design phase. There will be a need for support to the excavation. This is considered to be of moderate significance. Take appropriate health and safety measures to protect the public and staff members on site.
4.2 - 12	Will the proposed basement significantly increases the differential depth of the foundations relative to neighbouring properties?	**Potential Impacts:** The proposed SSL foundation level of the Plot 3 basement is approximately +11.95m AOD. The proposed SSL foundation level of the Plot 1 basement is approximately +7.8m AOD. The level of foundations of the Eastman Dental Clinic and Alexandra Wing were investigated in February and August 2020. An increase in differential depth can lead to increased soil movement. It is considered that EDC and Alexandra Wing basement SSL level is approximately +16.0m OD. **Actions:** Investigations have been completed to understand foundation depths of surrounding buildings and modelling of any potential impacts the proposed development will have on surrounding assets.
4.3 - 1	As part of the proposed site drainage, will surface water flows (e.g. volume of rainfall and peak run-off) be materially changed from the existing route?	**Potential Impacts:** Increased levels of surface water flows can lead to an increased risk of flooding. **Actions:** A sustainable drainage system will be used on site to reduce the rate of peak run-off and improve the drainage conditions from their current state. Refer to the Drainage Strategy for more details on the proposed sustainable drainage systems.
4.3 - 3	Will the proposed basement result in changes to the profile of the inflows (instantaneous and long term) of surface water being received by adjacent properties or downstream water courses?	**Potential Impacts:** Profile of inflows of surface water to surrounding properties will be affected by the development of the site. Potentially leading to increased levels of surface runoff and increased risk of flooding. **Actions:** The use of a sustainable drainage system will lead to an improved inflow profile of surface water to surrounding properties. Refer to the Drainage Strategy for more details on the proposed sustainable drainage systems.

6. CONCEPTUAL GROUND MODEL

The ground conditions for Plot 1 are summarised in Table 6.1 using information from the GIR; these are assumed to be applicable and consistent across Plot 3. The Plot 1 investigation works were carried out between 22nd May and 20th July 2018 and comprised:

- 2 No. cable percussive boreholes to a maximum depth of 46.90m;
- 2 No. cable percussive boreholes with rotary follow on to a maximum depth of 60.00m;
- 3 No. windowless sample boreholes to a maximum depth of 9.00m;
- 8 No, hand excavated trial pits to a maximum depth of 1.60m;
- 1 No. observation pits to a maximum depth of 0.80m;
- Pressuremeter testing;
- Permeability testing;
- Logging and photographing;
- Instrumentation monitoring and sampling;
- Geotechnical and chemical testing;
- Vibration testing.

A site-specific investigation for Plot 3 has been scoped, in order to confirm if there is a potential change in ground conditions or ground variability. The scope of works include:

- 6no. hand dug observation pits (2m bgl or until determining foundation level, whichever is greater) – machine use to be agreed with the Investigation Supervisor;
- 4no. windowless samples (6m bgl);
- 2no. cable percussive boreholes with rotary core follow on in London Clay to 40m bgl;
- In-situ testing (standard penetration testing);
- Groundwater monitoring;
- Ground gas monitoring;
- Geotechnical laboratory testing.

Detailed information on the Plot 3 scope, exploratory hole locations and testing is included in BEMP-RAM-P3-XX-SP-CG-00-0001.

The following additional assessment have been carried out in relation to the site that are relevant to the basement:

- Arboricultural report, by Thompson Environmental Consultants
- Flood Risk Assessment, by Ramboll UK
- Surface Water Drainage Strategy, by Ramboll UK

These are provided as part of the planning submission and can be found in separate documentation.

A characteristic groundwater level of +9.4m AOD is anticipated. The Plot 3 basement formation level is proposed to be at approximately +11.5m AOD, with top of B2 slab at approximately +11.95m AOD (SSL). The Plot 1 basement formation level is proposed to be at approximately +6.5m AOD, with top of B2 slab at approximately +7.8m AOD (SSL).

Formation level is lower under the core and where the drainage tank is located. Shallow foundations are predicted for nearby buildings. There are no known rail tunnels beneath or near the site. The Metropolitan Railway (Clerkenwell cut-and-cover tunnel) runs in a southeasterly direction, from King's Cross to Farringdon Station within 250m east of the site. The closest tunnel is the Hammersmith and City Line which is approximately 200m to the northeast of the proposed extended site boundary. It is undertood there are 1no. storey basements for the Grayland Court (1), Aelxandra Wing (4), Eastman Dental Clinic (5), 1-8 Mecklenburgh Street (7), Frances Gardner House (8), Langton Close Residences (9) developments; these have been accounted for within the damage assessment analysis.

Surrounding assets in proximity to Plot 1 that have been assessed for the proposed basement excavation and retaining wall installation are highlighted in Figure 5.

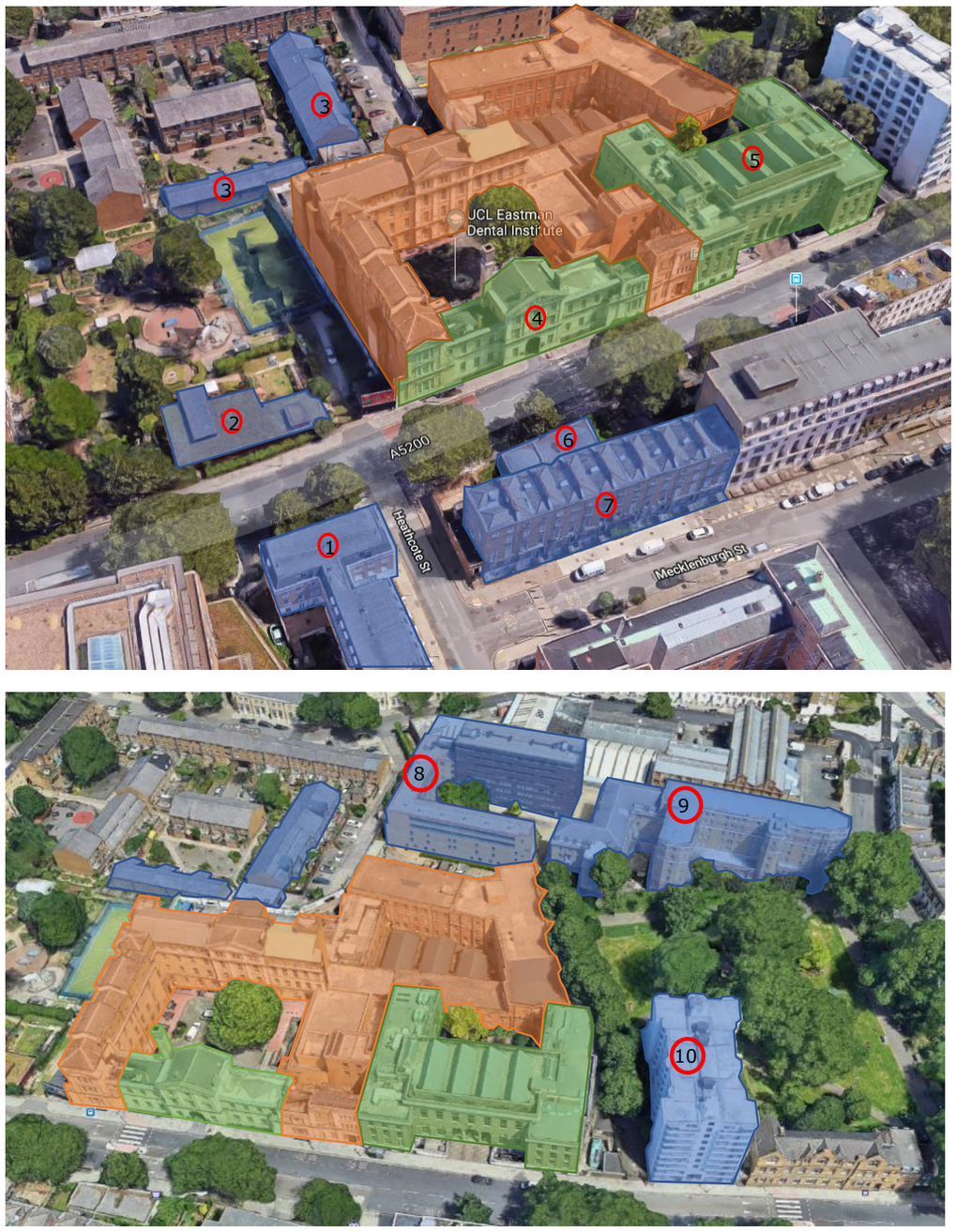


Figure 5: Site Layout and Position of Surrounding Structures Assessed

Table 6.1: Conceptual Ground Model of the Plot 1 site

Strata		Average level at top of Stratum (m AOD)	Average thickness (m)	Typical Description
Made Ground		20.4	3.1	Brown/ greyish, clayey/silty/gravelly, sub-angular to sub-rounded fragments of flint, brick, and concrete.
River Terrace Deposits		17.3	1.3	Medium dense, brown sandy clayey sub-angular fine to coarse flint GRAVEL.
Weathered London Clay		16.0	3.55	Firm, brown mottled bluish grey silty CLAY, with occasional pockets of silty fine sand.
Un-weathered London Clay		12.45	13.05	Stiff extremely closely fissured brownish grey slightly micaceous CLAY, with occasional pockets of dark grey silt and fine sand.
Lambeth Group	Upper Mottled Beds	-0.60	6.4	Stiff to very stiff, brown mottled bluish grey CLAY.
	Laminated Beds	-7.0	1.2	Stiff to very stiff, dark grey silty CLAY with extremely closely spaced laminations of light brown silt and fine sand.
	Lower Mottled Beds	-8.2	6.3	Very stiff dark grey to light bluish grey sandy silty CLAY, with occasional calcrete cemented silt nodules
	Mottled Upnor Formation	-14.5	1.8	Very stiff, greenish grey mottled sandy silty CLAY. Sand is fine and glauconitic.
	Upnor Formation	-16.3	4.7	Very stiff dark grey slightly gravelly silty CLAY, with occasional pockets of light grey and green fine sand.
Thanet Sands		-20.0	3.8	Very dense brown SAND with occasional pockets of dark grey clay.
Chalk Formation		-23.8	-	Weak to medium strong, medium to high density CHALK. Grade Dm to B3/B4

7. EXISTING NEARBY STRUCTURES

Figure 6 highlights the locations of nearby structures. In particular, the Eastman Dental Clinic is a Grade II Listed building, along with residential assets associated with 1-8 Mecklenburgh Street and the fountain in the courtyard of Plot 1. According to CIRIA C760 ground movements associated with the construction of the basement and retaining walls could theoretically extend to the properties mentioned below.

1. The Alexandra Wing of the RFH on Plot 1 is to be retained. The proposed basement does not extend beneath the Alexandra Wing. It is a combination of brick and stone masonry construction. Built in the 1800s. It is composed of up to three storeys above ground with 1no. storey basement.
2. Eastman Dental Clinic is part of the site and constitutes Plot 2. It is the only building on the site not due to be demolished along with the Alexandra Wing of Plot 1. It was built between 1926 and 1931. It is a steel structure with masonry walls spread over four storeys above ground with 1no. storey basement. It is Grade II listed.
3. Grayland Court northwest of Plot 1 is a masonry built apartment block built in the early 1990s comprising five storeys including an undercroft / 1no. storey basement floor.
4. The Calthorpe Project centre is a community facility to the north of Plot 1. A single-storey structure (assumed timber) and considered to be built in the 1980s – 1990s.
5. Two buildings of the New Calthorpe Estate border Plot 1. They are two and three storey masonry constructed terraced residential properties likely built in the 1980s. A masonry built boiler room is located between these two residential properties
6. Hubbards Cupboards is a single-storey retail building the other side of Grays Inn Road. It is unclear form historical maps when it was built. It is a masonry construction.
7. 1-8 Mecklenburgh Street is the other side of Hubbards Cupboards. It is a five-storey masonry structure including 1no. storey basement floor, comprising eight terrace houses now converted into flats. Historical maps appear to indicate it was built in the 1800s.
8. Langton Close Residences is a six-storey residential building used as university accommodation. It is of masonry construction and built prior to 1945.
9. Trinity Court is a nine-storey residential apartment block of masonry construction built between 1934 and 1935.
10. Frances Gardener House is a five-to-seven-storey residential building used as universirt accommodation. It is a masonry construction built in 2002. Below the northeast section of Frances Gardener House comprises a1no. storey basement.

The closest distances of the assets adjacent and within the anticipated influence zone of the proposed and combined Plot 1 and 3 development boundary is included within Figure 6.

In addition it should be noted that the existing retaining wall bounding the north of the Plot 1 site, the east of the site where the current car park is located and parallel to Seddon Street will be demolished over the majority of the length. Demolition of the wall is proposed where the Good's Yard adjoins into B1 level of the proposed development on the east of site. The demolished zone is indicated within Figure 6. The proposed contiguous wall piling line is aligned with the current retaining wall bounding the north of the site. The proposed contiguous wall piling line is inset from however parallel to the current retaining wall bounding the east of the site. The Plot 1 basement on the southeast of the site is to be extended to house a sprinkler tank at B2 level. In addition, it is also extended to the southwest of the site to house additional plant.

In the temporary case, the existing wall will be supported by props for stability, and the wall condition assessed with the opportunity to repair and monitor if required.

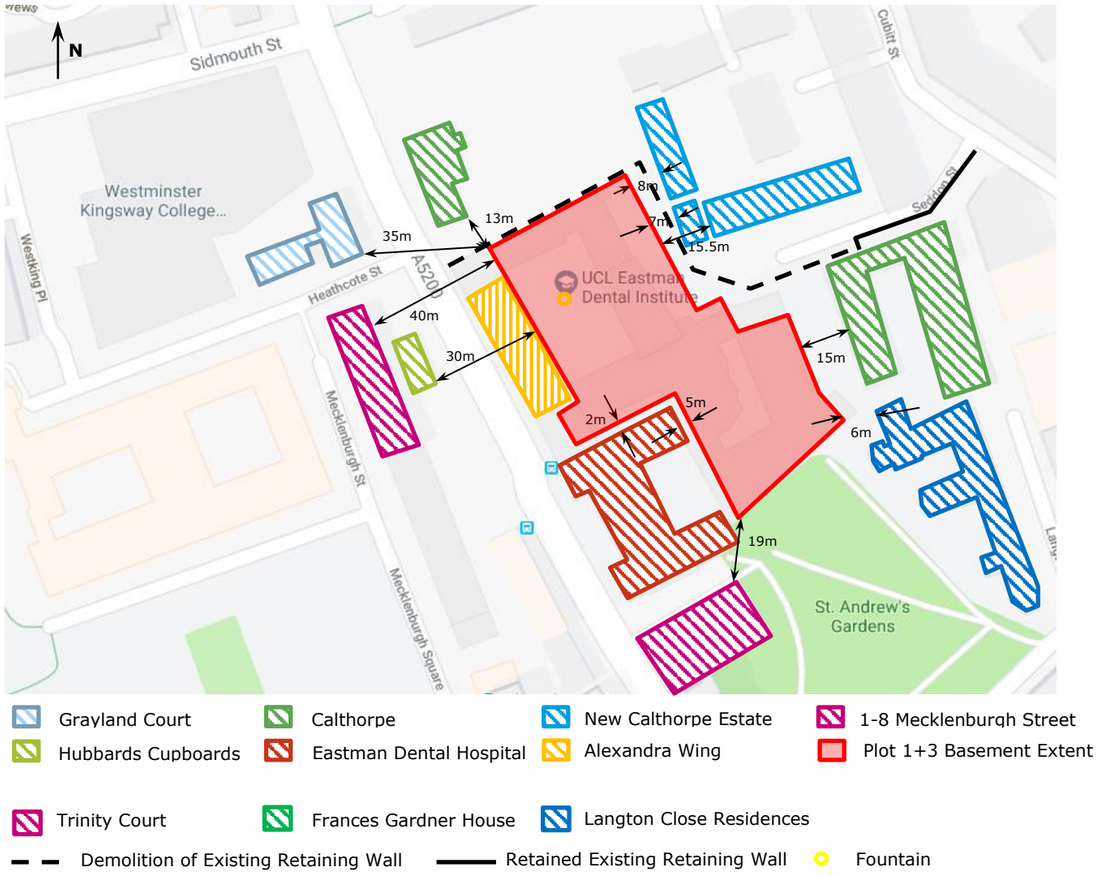


Figure 6: Identified Sensitive Nearby Buildings (N.T.S)

8. CONSTRUCTION SEQUENCE

Given the nature and location of the site, it is proposed to construct the basement using a contiguous piled retaining wall. An outline bottom-up construction sequence is summarised below and broadly representative of the overall excavation and build for the whole site. This involves the following stages for Plot 1:

1. Demolition and remove existing foundations
2. Installation of 900mm contiguous pile retaining wall (1000mm spacing) with short-term ($0.7E_{0I}$) concrete stiffness, where Piling Platform Level (PPL) is considered between +15.6m AOD to +16.8m AOD
3. Excavate to +14.5mOD
4. Insert Temporary Prop 1 at or above pile cap on blisters >+15.6m OD
5. Excavate to formation level at +6.5m OD
6. Construct B2 raft slab at +7.8m OD (top level) with short-term ($0.7E_0I$) concrete stiffness
7. Construct B1 slab at +15.6m OD (top level) with short-term ($0.7E_0I$) concrete stiffness and remove Temporary Prop
8. Model long-term drained soil behaviour and wall relaxation ($0.5E_0I$)

The strategy for Plot 3 follows similarly as presented below:

1. Demolition and remove existing foundations
2. Installation of 750mm contiguous pile retaining wall (850mm spacing) with short-term ($0.7E_0I$) concrete stiffness, with pile cut off level at approximately +15.8m AOD to +17.95m AOD.
3. Excavate to +14.5m OD
4. Insert temporary Prop 1 at or above pile cap on blisters >+15.8m OD
5. Excavate to formation level at +11.5m OD
6. Construct B2 slab at +11.95m OD (top level) with short-term ($0.7E_0I$) concrete stiffness
7. Construct B1 slab at +15.8m OD (top level) with short-term ($0.7E_0I$) concrete stiffness and temove Temporary Prop
8. Model long-term drained soil behaviour and wall relaxation ($0.5E_0I$)

This sequence of works has been modelled for various sections of the site using Oasys Frew and the resultant ground movement curves have been incorporated into the building damage assessment. This is further discussed in Section 9.

The construction sequence and temporary works will be finalised by the appointed piling contractor. It should be noted that pile cap levels vary around different perimeter sections for Plot 1, between +15.6m OD and +16.8m OD, and Plot 3, between +15.8m AOD and +17.95m AOD.

Based on the information from the GIR, the basement formation level for both Plots will be within the London Clay.

It is proposed that a contiguous pile wall will be required and suitable temporary works will be installed to limit the ground movements during excavation to the basement formation level. As there is a risk of ground swelling due to the excavation, provision for heave mitigation will be considered within the foundation design, during the detailed design stage.

An outline preliminary bottom-up construction sequence is shown in Figure 7, which shows a section through a typical wall for the Plot 3 proposed development.

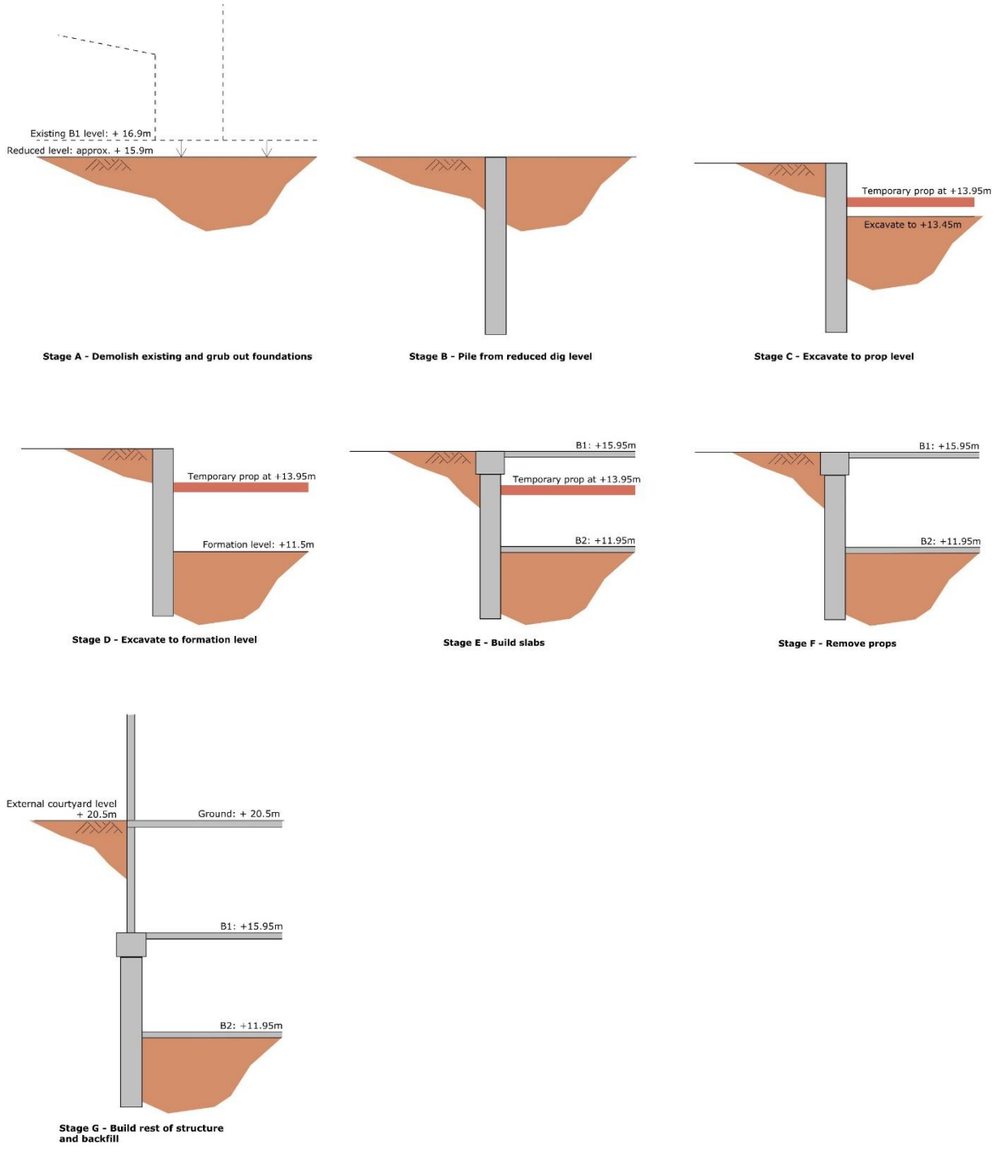


Figure 7: Assumed Construction Sequence for a typical Plot 3 Section

9. GROUND MOVEMENT ASSESSMENT

The key construction activities that will result in ground movement during the works are:

- Installation of basement piled retaining wall;
- Excavation to formation level;
- Construction of new building.

Oasys Xdisp (Version 20.1) is used to calculate the anticipated horizontal and vertical movements due to the installation of the piled wall and excavation of the basement together with the resulting movement seen by the neighbouring properties. An excavation below Plot 1 basement level and Plot 3 ground level from approximately +17.0m OD to formation level of +6.5m OD and +11.5m OD, was modelled over the Plot 1 and the Plot 3 contiguous pile wall boundaries respectively. Contiguous pile installation was modelled to be undertaken from pile cap level of +15.5m OD for both Plots. This considers the permanent works. The change in levels of applied excavation effects and installation effects are negligible. It should be noted that corner stiffening due to retaining wall installation has been considered within the analyses.

Oasys Frew analysis was undertaken for several sections of the site; Figure 9 shows the concerning cross-sections for site. The Frew analyses includes for any retained soil height and/or basement footing surcharges from pile cap to ground level – the associated deflection and hence vertical settlement profiles incorporate these effects into the analysis.

Pile toe levels will be goverened either by the axial load capacity or stability. Based on Plot 1 and Plot 3 axial load conditions and retaining sections, a conservative toe at -4m OD is considered for the entire combined basement scheme.

- 1 & 2 – Alexandra Wing Sections for different existing and proposed footing loads
- 3 – Eastman Dental Clinic (EDC)
- 4 – Calthorpe Estate
- 5 – Good's Yard / Loading Bay
- 6 – New Calthorpe Estate
- 7 – London Fire Brigade (LFB) Core
- 8 – Plot 3 Loading Bay
- 9 – Plot 3 St. Andrews Gardens
- 10 – Plot 3 EDC

The respective vertical soil displacement curves for excavation (worst-case curves used for each perimeter boundary) were input into Xdisp to provide more representative profiles based on site-specific variations, compared with using in-built curves based on derived relationships in CIRIA C760. The relationship between analysed lateral (propped) wall deflections and predicted ground settlements in stiff ground has been calculated in accordance with the relationship in CIRIA C760; this is shown in Figure 8.

A comparison of each critical perimeter ground displacement curve compared with Xdisp inputs is shown in Figure 10 for Plot 1 and Figure 11 for Plot 3. The vertical movements behind the wall resulting from excavation are applied from pile cap level to ground level, therefore buildings with shallower basements or no basements have the same settlement induced, for this assessment.

It should be noted that the design of the temporary works to restrict surrounding ground movements to acceptable levels is incorporated into the Deep Basement Construction Plan (DBCP) by the appointed temporary works contractor.

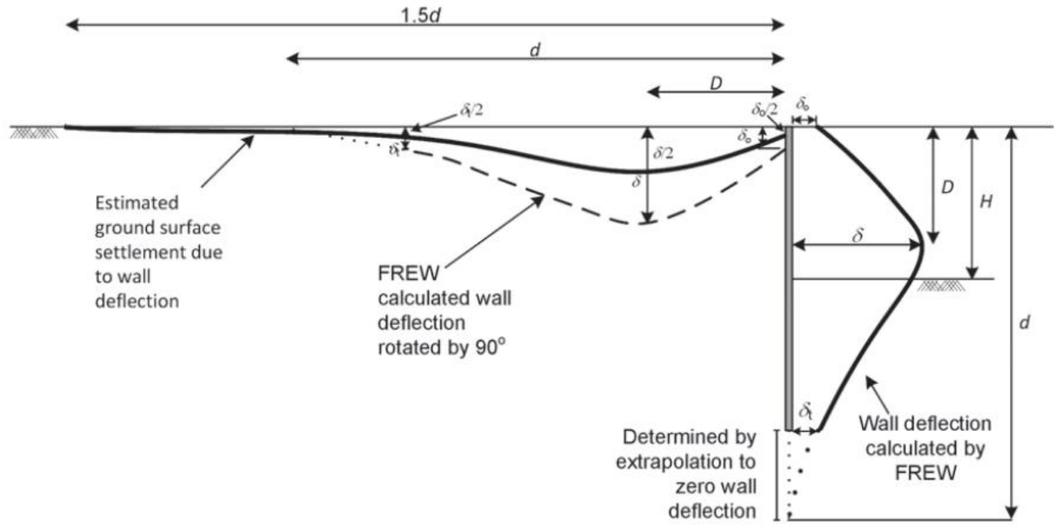


Figure 8: CIRIA C760 Relationship between Propped Lateral Wall Deflections and Ground Settlements in Stiff Ground

In addition, the effects of installation can be considered to be reduced further to several case studies of projects undertaken within London, considering typical London ground conditions. This considers that installation movements can be halved based on piling methodology (hit one, miss three), good quality workmanship and monitoring. References include:

- Prediction of party wall movements using Ciria Report C580 (Ball et. al, 2014)
- Benchmarking Empirical Methods of Prediction of Ground Movement for Deep Excavations (Bologna, 2017)

The software calculates the likely maximum vertical and horizontal strain at the assumed location of the neighbouring properties foundations which then enables an estimation of the building damage category for the neighbouring properties. It should be noted that building damage assessment criteria is based on a damage assessment to masonry assets (Boscardin and Cording, 1989); this is the most onerous and therefore conservative for other structure types.

Figure 9: Contiguous Pile Retaining Wall Sections Analysed in Oasys Frew

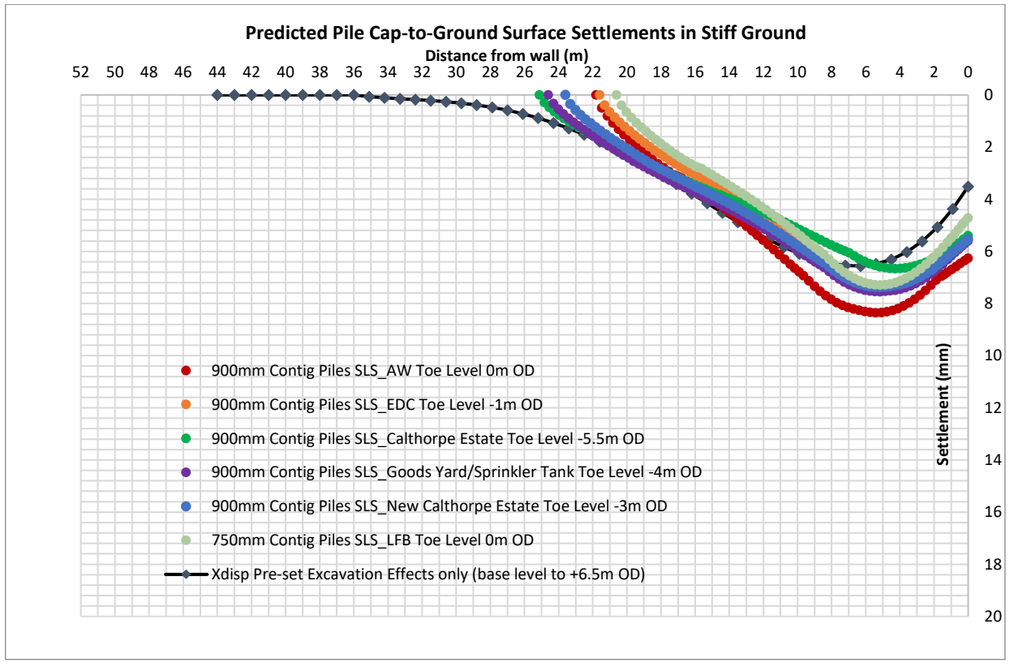


Figure 10: Predicted and Calculated Pile Cap-to-Ground Surface Settlements in Stiff Ground from Lateral (propped) Wall Deflections for Plot 1

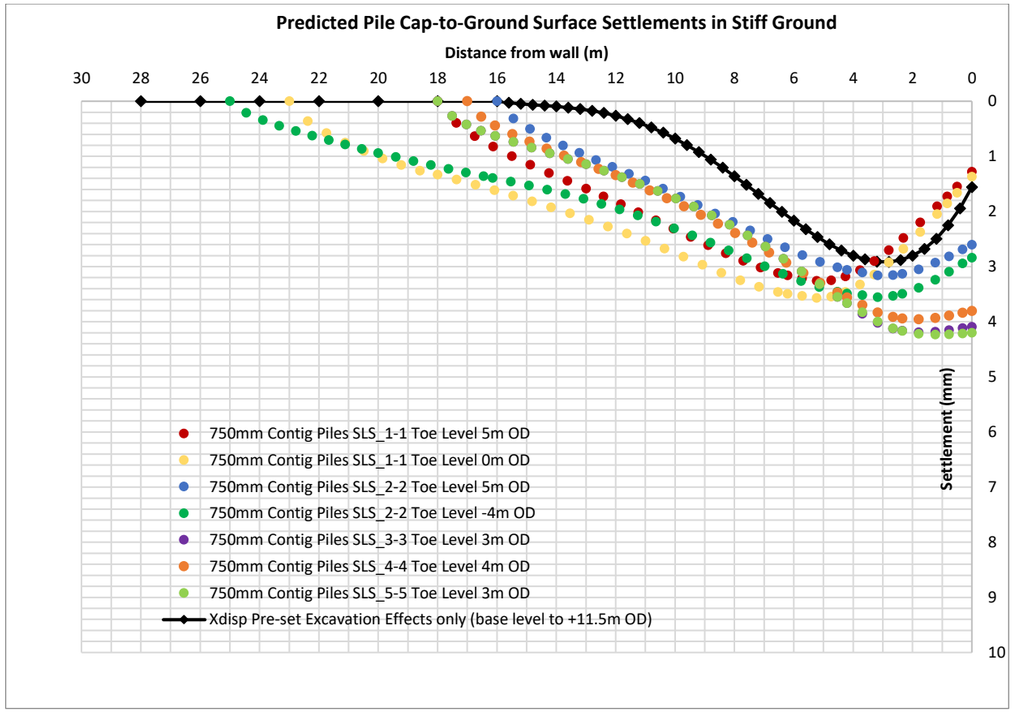


Figure 11: Predicted and Calculated Pile Cap-to-Ground Surface Settlements in Stiff Ground from Lateral (propped) Wall Deflections for Plot 3

The behaviour of the London Clay is highly non-linear therefore would require a higher level of complexity to accurately assess the heave movements, than is proportionate at this stage.

The amount of ground movement caused by these activities relates to the ground conditions, size of walls, presence of props, along with the care and sequence with which the works are carried out. This preliminary analysis has been carried out based on a sequence of construction described in Section 8 i.e. bottom-up construction; should the Contractor propose to carry out the works in a different sequence to that assumed in this design then a refined assessment of the predicted ground movements will be required, and the proposal only accepted if there is no significant change to the accepted scale of predicted movements.

In using Oasys Xdisp software, several assumptions are used/made in order to produce a conservative damage assessment. These include:

- Calculating movement applied from pile cap to ground surface level where it is likely to be most onerous and the excavation taking place in greenfield conditions. Oasys Frew retaining wall analyses curves have been used to supersede the CIRIA C760 Fig 6.15 (b) (excavation in front of high stiffness wall in stiff clay). Installation displacement curves have been implemented considering the two references (Ball et al 2014; Bologna, 2017) to supersede the CIRIA C760 Fig 6.8 (b) (installation of contiguous bored pile wall in stiff clay) to estimate the ground movements due to the installation of the piled wall;
- The average horizontal ground strain is transferred directly into the structure which is independent of building footing level and considers displacements to be the same between pile cap to ground surface level, however in reality the horizontal ground strain will reduce laterally and with depth to where the footings are actually founded;
- When re-entrant corners are present in the excavation the predicted ground movements in front of each side are added together. This is a significantly over conservative assumption.

- The contribution of demolition unload effects of the existing development will be negligible and hence discounted – the Plot 1 site comprises 4no. Wings as part of the Royal Free Hospital and a central courtyard. The works comprise demolition of 3no. Wings to ground level behind the retained façade. Plot 3 comprises the Levy Wing and the works comprise the demolition of the entire building; and
- The unloading due to the excavation or proposed development/ construction loading has not been analysed as it is considered that the proposed construction timescales are such that construction will be continuous therefore excavation heave effects will be counteracted relatively promptly by casting the raft and foundation pile caps, and construction of the substructure and superstructure. Ground movements within the contiguous pile wall box are considered to be contained and hence have negligible impact on the surrounding assets.

The existing nearby structures identified in Section 7 were considered on the basis of their proximity and position relative to the basements, where the greatest predicted soil movement will be. As such these represent the properties at greatest risk; this is graphically shown in the 3D image with respective damage category designation in Figure 12. A settlement (vertical) contour has been produced, as shown in Figure 13.

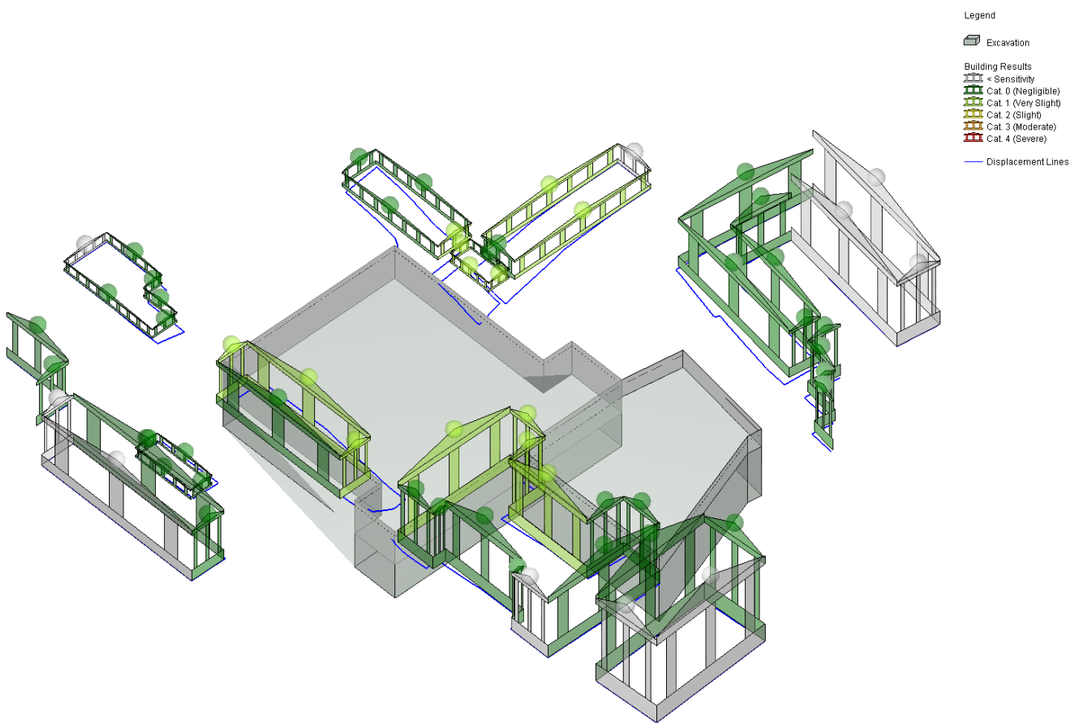


Figure 12: 3D Building Damage Results based on Combined Plot 1 and Plot 3 Basements

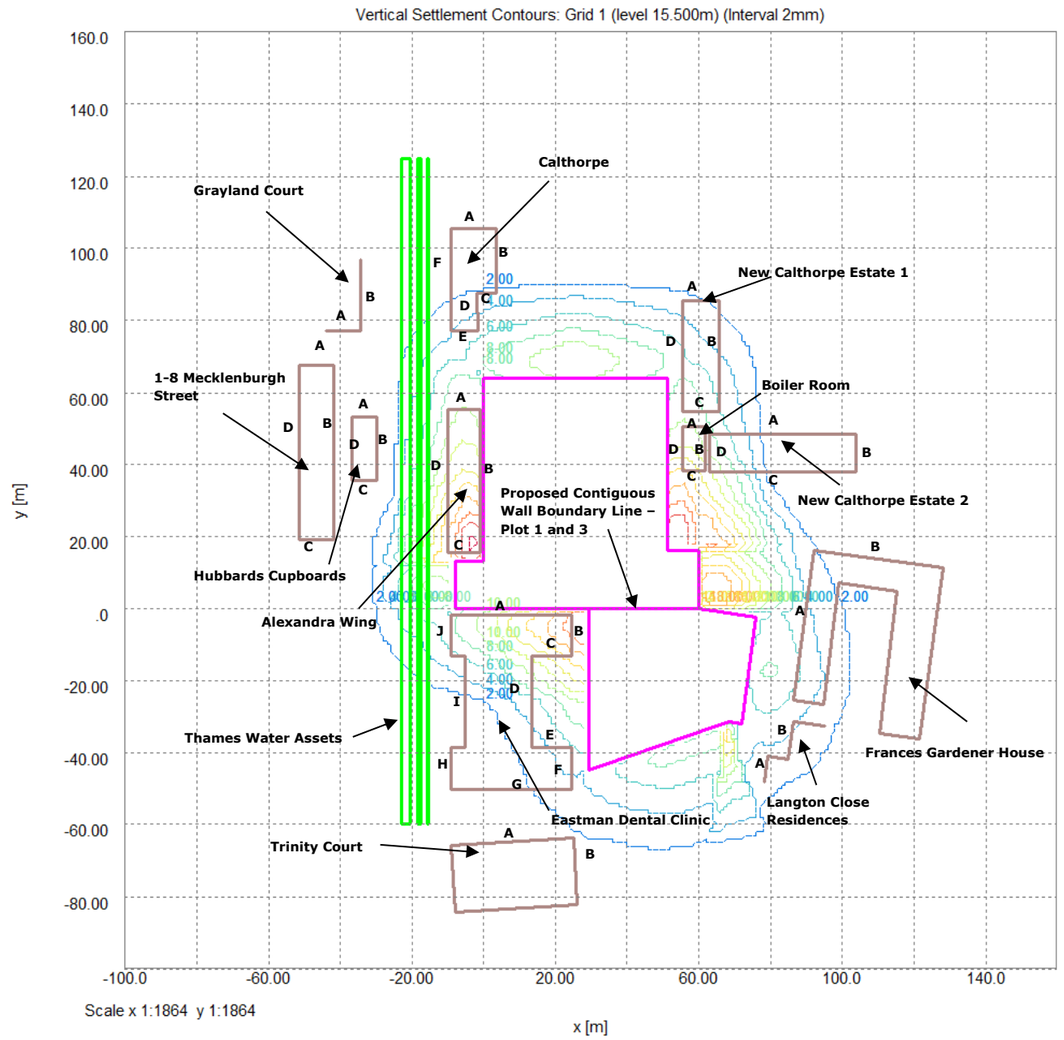


Figure 13: Contour Plot of Vertical Settlement Contours at B1 Level (*same at +20m OD*)

These assets have been modelled in Xdisp software as displacement lines, therefore ground movements have been calculated at these locations and a damage assessment based on CIRIA C760 methodology has been undertaken.

The majority of the assets in proximity to the Plot 1 and Plot 3 development have been modelled as simplified polygonal displacement lines. It is considered that displacement lines perpendicular to the excavation experience the greatest differential movement and have the greatest damage potential. The change in horizontal displacements with distance away from the development area are noted to have the most significant change whilst propagating away from the excavation area, as seen in Figure 14.

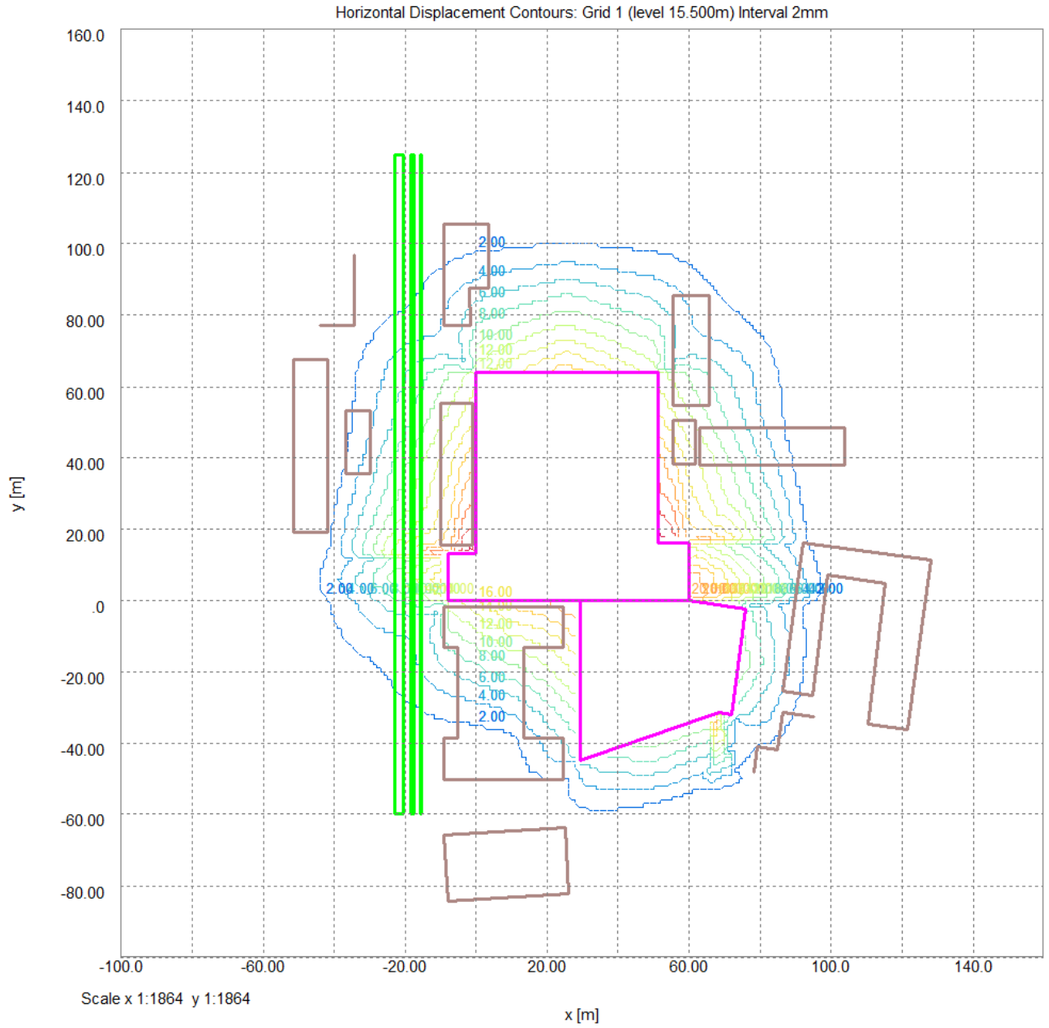


Figure 14: Contour Plot of Horizontal Soil Movement at B1 Level (*same at +20m OD*)

10. DISCUSSION OF PREDICTED GROUND MOVEMENTS

The structures that are closest to and surrounding the excavation were chosen for assessment as these will experience the greatest movement and potential for differential movement.

The results of the preliminary ground movement assessment can be seen in Table 10.1. The strains and resultant damage predicted falls between Category 0 (Negligible) to Category 1 (Very Slight) on the Burland Scale of Damage. It should be noted that only the critical walls for each asset have been summarised in Table 10.1. For structural walls which have not been summarised have a predicted Damage Category 0. A Draft Construction Management Plan (CMP) has been developed by the project advisor for the proposed construction; this will include the monitoring requirements set out in the Ramboll movement monitoring strategy in order to control the predicted movement.

It is proposed that movement monitoring is carried out on the piled wall and basement box along with structures falling under Damage Category 1 prior to and during the proposed basement construction. An initial monitoring strategy has been produced by Ramboll which includes the monitoring proposals for surrounding buildings including the Eastman Dental Clinic and adjacent buildings that may be influenced from the construction of the proposed development.

The differential movement across the width of the surrounding properties could lead to minor cracks appearing in the walls and in the finishes. As explained in this report the scale of movement predicted could lead to fine cracks easily treated during normal redecoration. Finishes to floors, walls, and ceilings can be more susceptible to cracking as a result of this movement, especially brittle finishes. These are considered to be superficial and non-adverse.

The final construction sequence will be developed to take account of limitations established during the detailed design phase. Should the contractor propose to carry out the works in a different sequence to that assumed in our design then a further assessment of the predicted movement will be required, and the proposal only accepted if there is no significant change to the scale of predicted movement.

On the basis of the assumed construction methods and sequence, the ground movement analysis suggests a maximum damage to the neighbouring properties is likely to remain within Category 1 ('Very Slight') damage. To ensure the movements remain within acceptable limits, movement monitoring has been proposed. The Contractor will be required to carry out detailed monitoring of the surrounding properties to record ground movements and take appropriate action should the movement not be as expected.

10.1. Mitigation measures

Measures to mitigate potential damage as a result of ground movements include, but are not limited to:

1) Propping of the retaining wall during construction to limit deflection;
2) Temporary works to ensure stability of existing structures;
3) Movement monitoring and assigned trigger levels and mitigation measures. Trigger levels should also be set prior to construction phase to identify limits on monitored results and to define actions and mitigation measures if these limits are reached and/or exceeded. The traffic light approach could be adopted with green, amber, and red trigger levels set;
4) Monitoring locations are recommended to include, but not limited to:
   a) Façade (Alexandra Wing, EDH, Frances Gardener House, Calthorpe Estate Assets, St. Andrews Garden retaining wall);
   b) Retaining Walls;
   c) Raft;
   d) Temporary Props;
   e) Pavement Monitoring;
   f) Groundwater Monitoring including the installation of standpipes around the site to ascertain grounwater levels outside of the excavation. This will be required prior to, during and post development construction. Data should be collected for groundwater levels over the winter months as part of the baseline pre-construction monitoring;
   g) Vibration Monitoring; and
5) Piling methodology (hit one, miss three) and good quality workmanship.

Table 10.1: Maximum Settlement, Strain and Burland Category of Damage for each Nearby Structure

Structure	Displacement Line	Max Settlement (mm)	Strain (%)	Burland Category of Damage
Alexandra Wing	AW_A	10	0.053	1 (Very Slight)
	AW_B	23	0.070	1 (Very Slight)
	AW_C	23	0.066	1 (Very Slight)
Eastman Dental Clinic (EDC)	EDC_A	20	0.055	1 (Very Slight)
	EDC_B	21	0.066	1 (Very Slight)
	EDC_C	17	0.055	1 (Very Slight)
	EDC_D	12	0.052	1 (Very Slight)
New Calthorpe Estate 1	FS1_C	9	0.054	1 (Very Slight)
New Calthorpe Estate 2	FS2_A	9	0.051	1 (Very Slight)
	FS2_C	12	0.062	1 (Very Slight)
Boiler Room	BR_A	10	0.056	1 (Very Slight)
	BR_C	17	0.066	1 (Very Slight)
	BR_D	17	0.055	1 (Very Slight)

Note: Hubbards Cupboards, 1-8 Mecklenburgh Street, Calthorpe and Grayland Court etc. asset walls have a predicted Damage Category of 0 i.e. Negligible

11. NOISE, VIBRATION AND DUST

Vibration and noise can be controlled by adopting appropriate piling techniques, offering minimal vibration and low noise levels. Dust control measures will be implemented to reduce or prevent the surface and air transport of dust during construction including, but not limited to:

- Sheeting and screening - Area will be screened with suitable debris screens and sheets;
- Site traffic - Vehicle movements will be kept to a minimum and vehicle speeds limited;
- Water sprays - Spraying should be carried out prior to and during demolition, and any works causing excess dust expulsion;
- Removal of materials from site - Materials should be removed from the site as soon as is practical;
- Cutting, grinding - Employ equipment and techniques that minimise dust emissions, using best available dust suppression measures.

Further details are set out in the project Draft Construction Management Plan (CMP).

Vibration testing was carried out as part of the site-specific ground investigation works to ascertain background levels for the design of the building for sensitive instrumentation and equipment.

12. TRAFFIC MANAGEMENT AND SITE ACCESS

Traffic Management outlined in the project Draft CMP, inclusive of the Outline Construction Logistics Plan. Main Contractors are to provide traffic management sequences and planning as part of the submissions to meet local authority requirements.

Vehicles will access the site from Grays Inn Road and Langton Close to load and unload material. Hoarding will be installed along these routes and the perimeter of the site to provide appropriate screening and security of the site during construction.

13. HANDLING MATERIALS AND WASTE

Method statements and procedures for the storage and handling of fine, powdery and dry materials will be established and agreed in detail with the contractor. It will include, but not limited to:

- Number of handling operations will be kept to a minimum by ensuring that dusty material isn't moved or handled unnecessarily;
- Use of closed tankers or sheeted vehicles for the transportation of dusty or powdery materials;
- Handling areas will be kept free and clean;
- Drop heights must be kept to a minimum when unloading;
- Fine and dry materials will be stored inside buildings or enclosures with adequate protection from the wind.

14. CONCLUSIONS AND FURTHER INVESTIGATIONS AND MONITORING

Based on the work undertaken as outlined within this report through conservative modelling of the basement construction, it has been demonstrated that the impact of the basement construction on surrounding structures can be mitigated through design and construction methods.

This report has outlined the proposed development scheme and summarised the structural stability of the surrounding building assets through conservative analyses, where the worst-case damage predicted falls between Category 0 (Negligible) to Category 1 (Very Slight) on the Burland Scale of Damage. This report also summarises that there is low risk of adversely affecting drainage and run off or causing other damage to the water environment. It should be noted that ground movements should be reduced by use of a temporary propping scheme for the basement and will be complemented with several forms of monitoring to provide assurance of construction works at several stages of the proposed development.

The risk of movement and potential damage limits have been assessed for several building assets directly adjacent to, and in close proximity to Plot 1 and Plot 3. The assessment has been carried out considering the effects of the contiguous pile retaining wall installation, the worst-case excavation across the whole site, the impact of basement retaining wall movements on neighbouring structures and construction of the new development. Thus far, analysis has used Oasys Xdisp to ascertain initial predicted damage categories for surrounding above ground structural assets. The modelling of the anticipated works for the combined Plot basement scheme result in a maximum Damage Category 1, equivalent to a 'Very Slight' degree of damage (approximate crack width of 0.1-1mm), at individual walls of the Alexandra Wing, EDC and New Calthorpe Estate structures. The influence of the Plot 3 basement extension does increase the magnitude of displacement and strains however does not increase the overall damage Category to unacceptable levels from the previous application.

This assessment is based on conservative greenfield analysis of the impact of Plot 1 and 3 on party walls and assets. The damage risk is driven by the horizontal strains imposed on the wall structures. Additionally, the stiffness and loading from existing foundations of the surrounding buildings and assets have not been taken into consideration during this analysis.

The following next steps can be undertaken as the design of the site is further developed post-planning submission;

- Construction methods are developed with the Contractor to feed into the ground movement analysis once the sequence of works is developed. To include for best practice control methods during piling including but not limited to 'hit one, miss three' approach and good quality workmanship;
- A pre and post works condition survey to be undertaken in relation to potentially affected surrounding properties and assets;
- A Draft Construction Management Plan (CMP) has been developed by the project advisor; this which will include the of monitoring requirements set out in the Ramboll movement monitoring strategy. A monitoring action plan for various stages of the project can be considered to monitor the existing structure and foundations, new walls and foundations and the adjacent Grade II Listed buildings. The extent of monitoring will be considered during the temporary works phase, the main works phase and potentially the post-construction phase;
- Completion of a Deep Basement Construction Plan (DBCP) by the appointed permanent and temporary works designers;
- Approval in Principle (AiP's) for the temporary and permanent basement construction is required from LB Camden Highways due to the proximity to TfL road networks, namely Grays Inn Road;
- Given the setting of the site and the derived Low to Medium Risk, it is recommended that consideration should be given to the potential risks to any below ground works posed by UXOs in accordance with CIRIA C681. Contractors to consider UXO mitigation on-site during probing, instrusive investigation, piling and excavation works;
- Undertake detailed foundation and retaining wall analyses and design;
- Completion of the Specification for Piling and Embedded Retaining Walls and further consultation with specialist contractors;
- Completion of the Plot 3 site-specific Site Investigation scoped;
- Agreement through the Planning application process from London Borough of Camden on the proposed methodologies and analysis within the BIA.